THE INSTITUTION OF PRODUCTION ENGINEERS JOURNAL

THE INSTITUTION OF

PRODUCTION ENGINEERS JOURNAL

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Vol. 37, No. 9 *Price 10/-* *September 1958*

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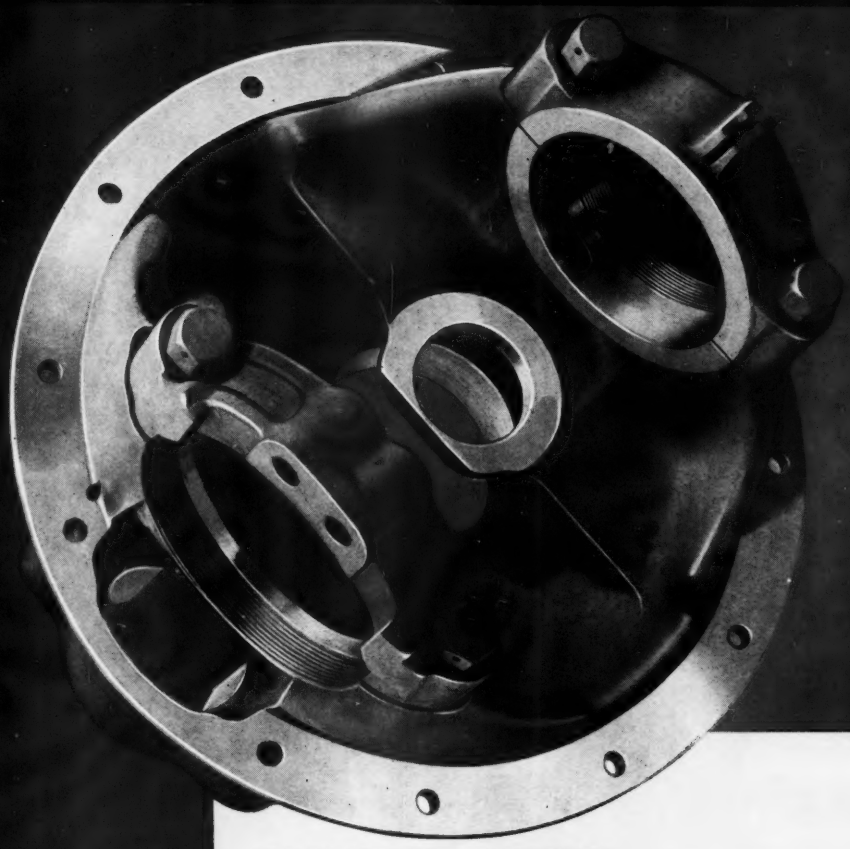
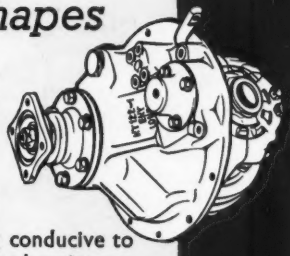


RIGIDITY–

with complex shapes



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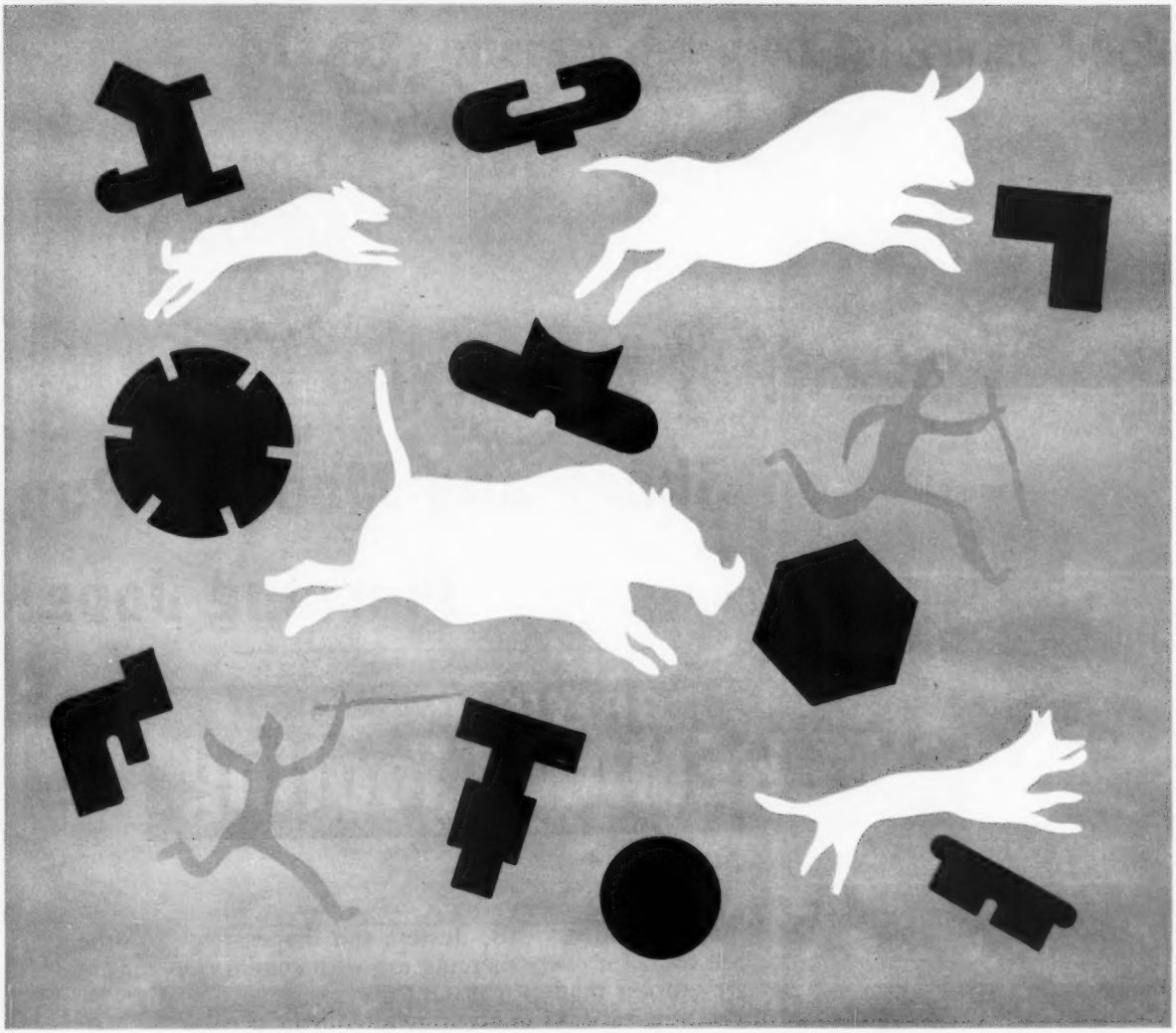

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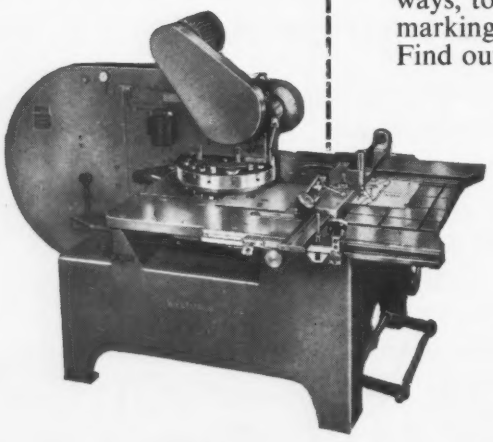

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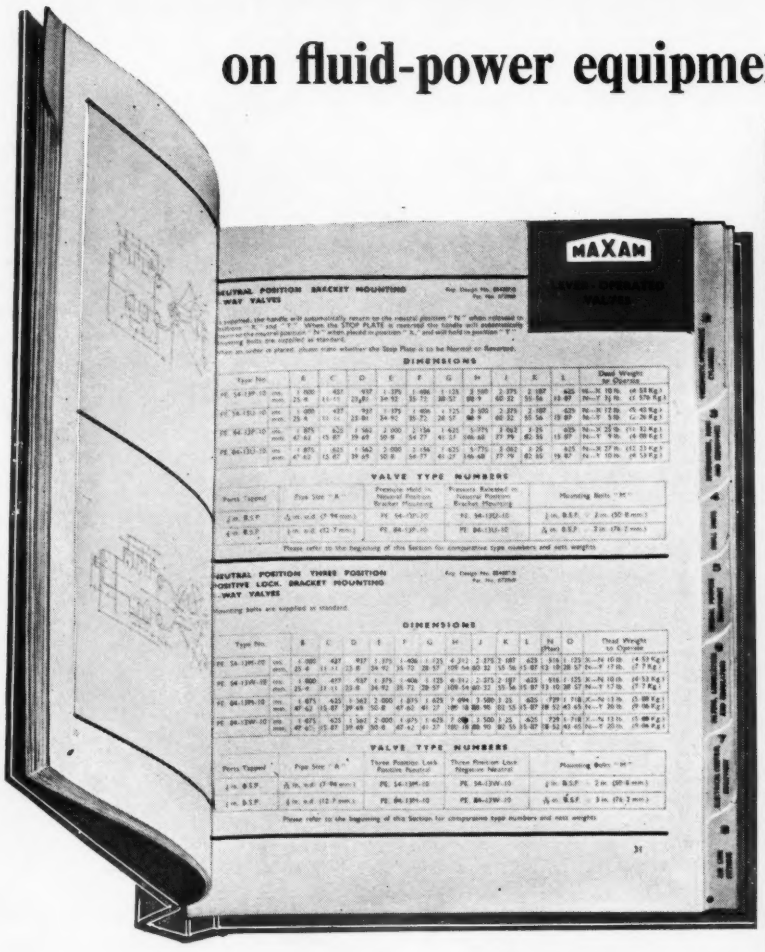

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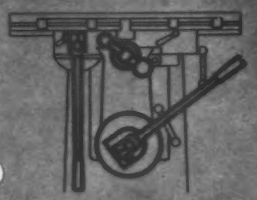
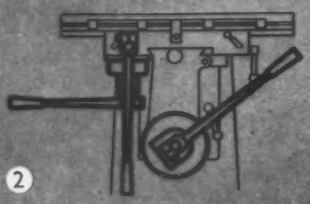
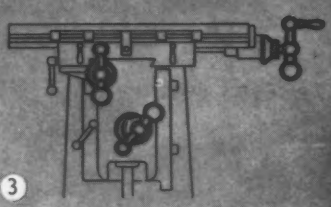


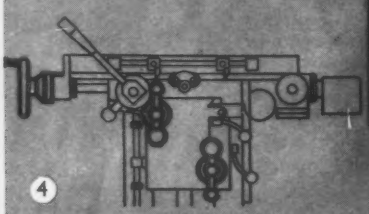
1 Hand Feed—lever, screw, lever.



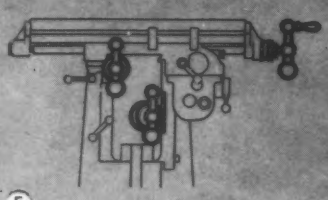
2 Hand Feed—lever, lever, lever.



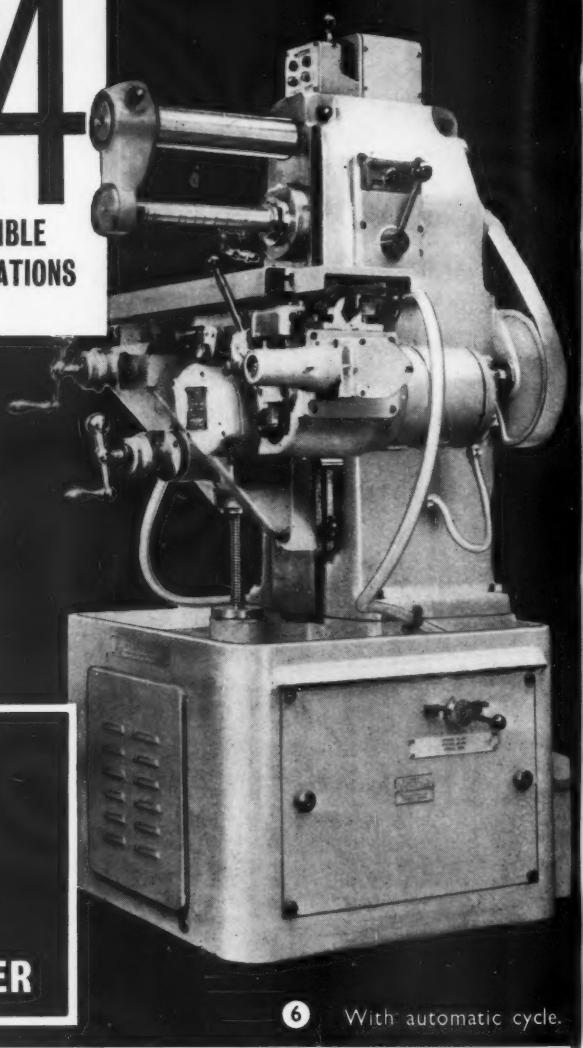
3 Hand Feed—Screw, screw, screw.



4 Multiform—semi-automatic cycle.



5 Normal automatic feed.



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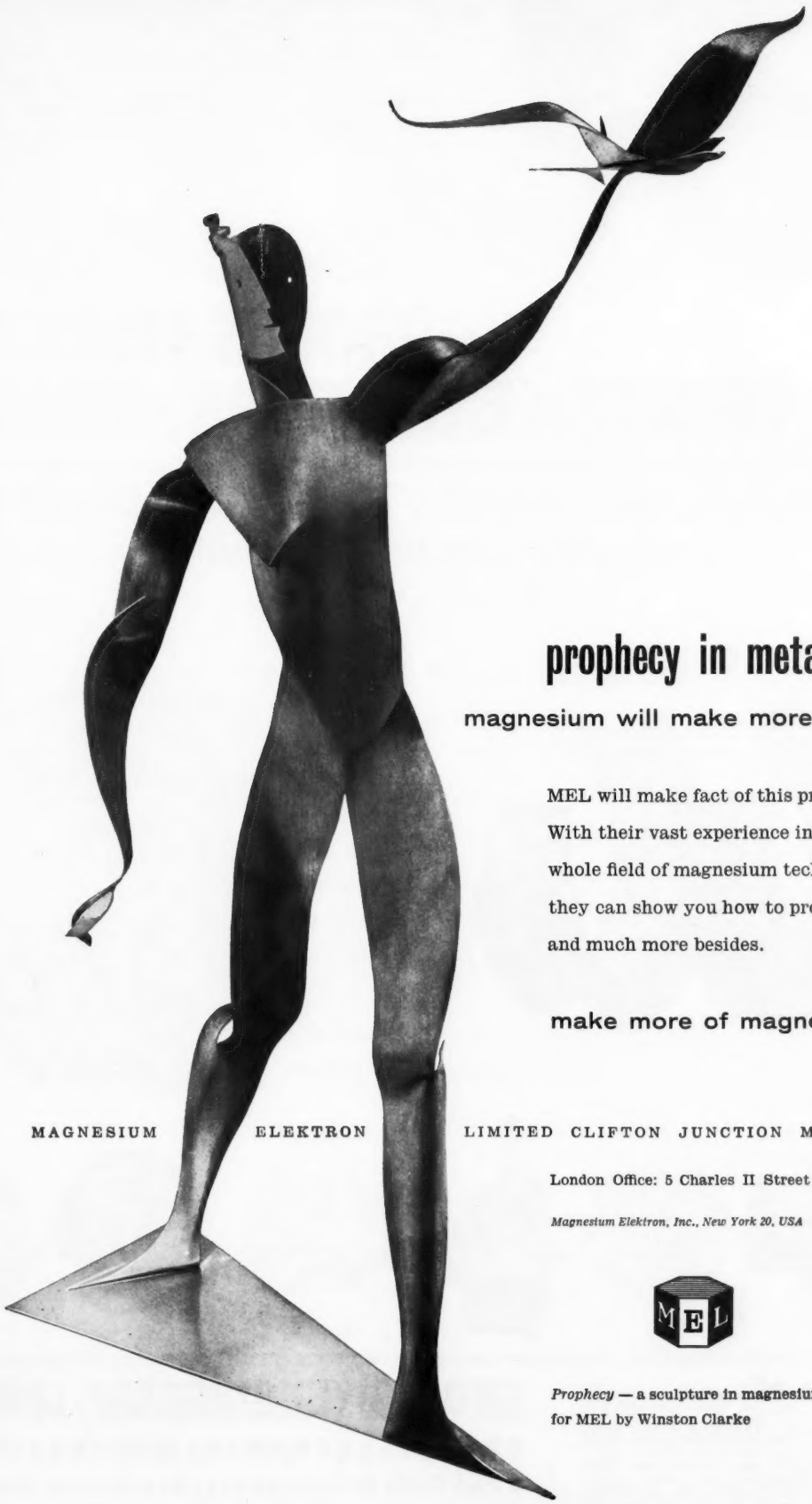

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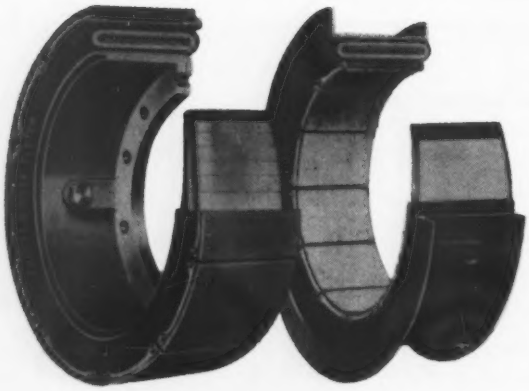

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Patent RO Disc Clutch

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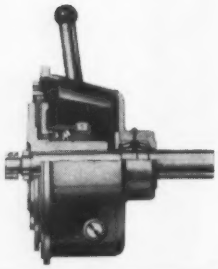

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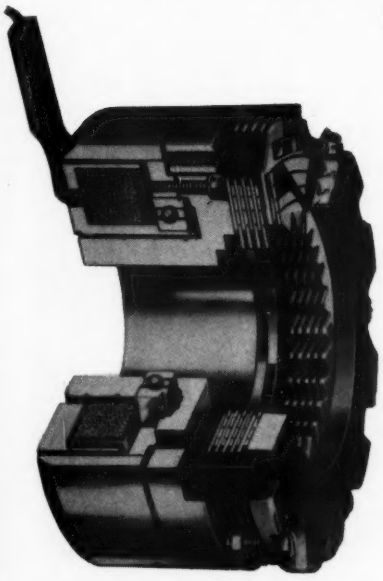

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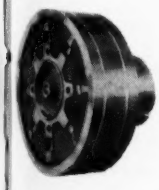
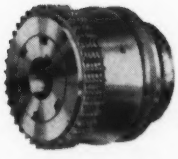
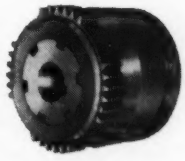


Automatic Centrifugal Clutch
Publication 5722



BOM-L Multiple Disc Clutch
Publication 855



Patent RM Multiple Disc Clutch
Publication 5613

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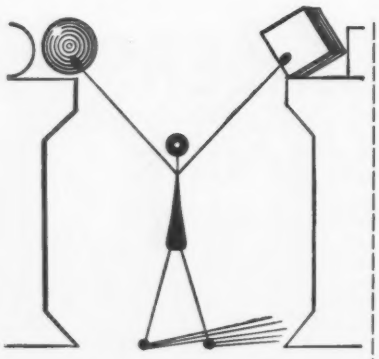
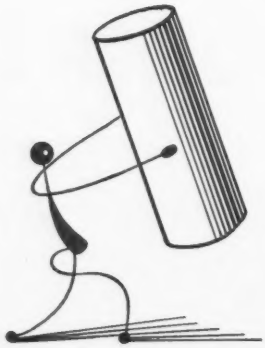
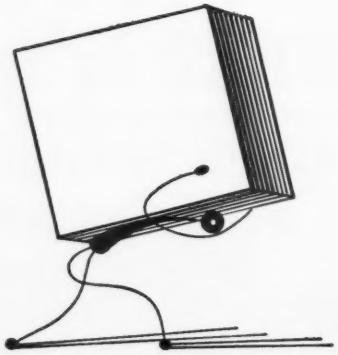


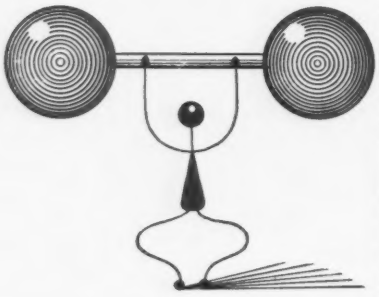
...reach...



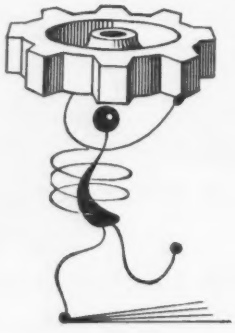
...grasp...



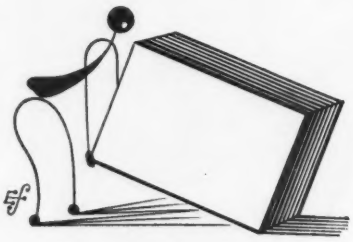
...carry...



...lift...



...turn...



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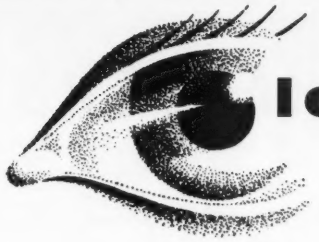

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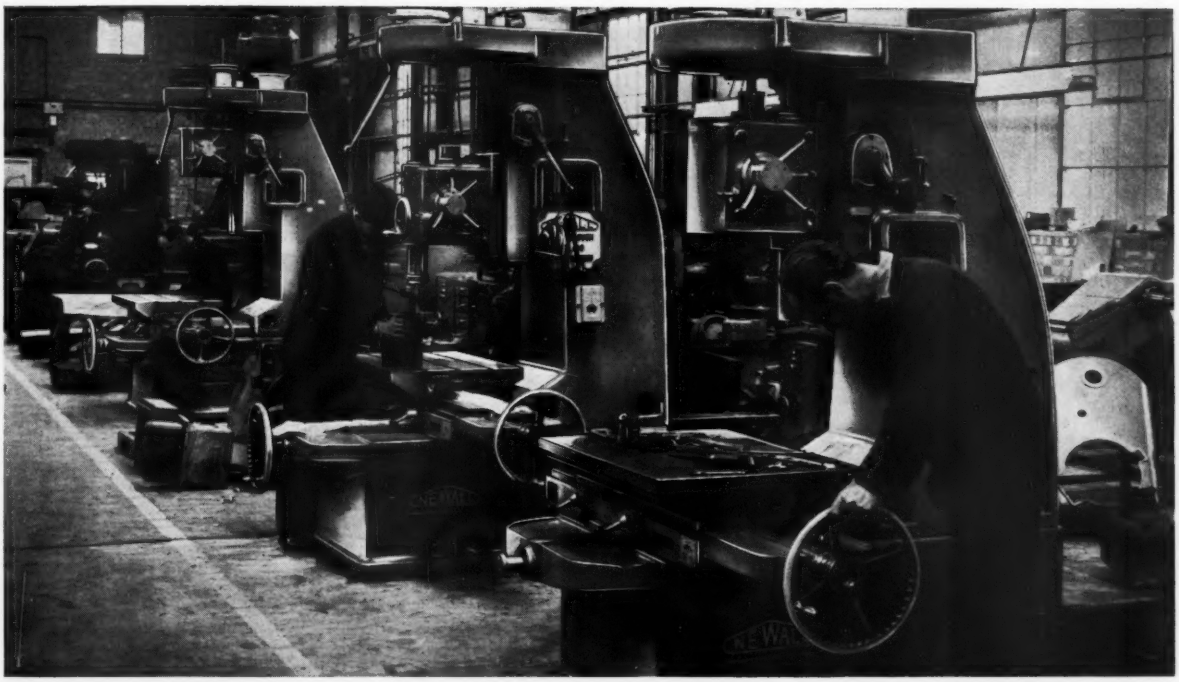

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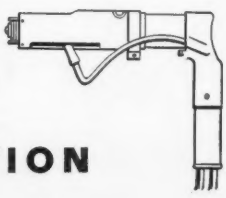

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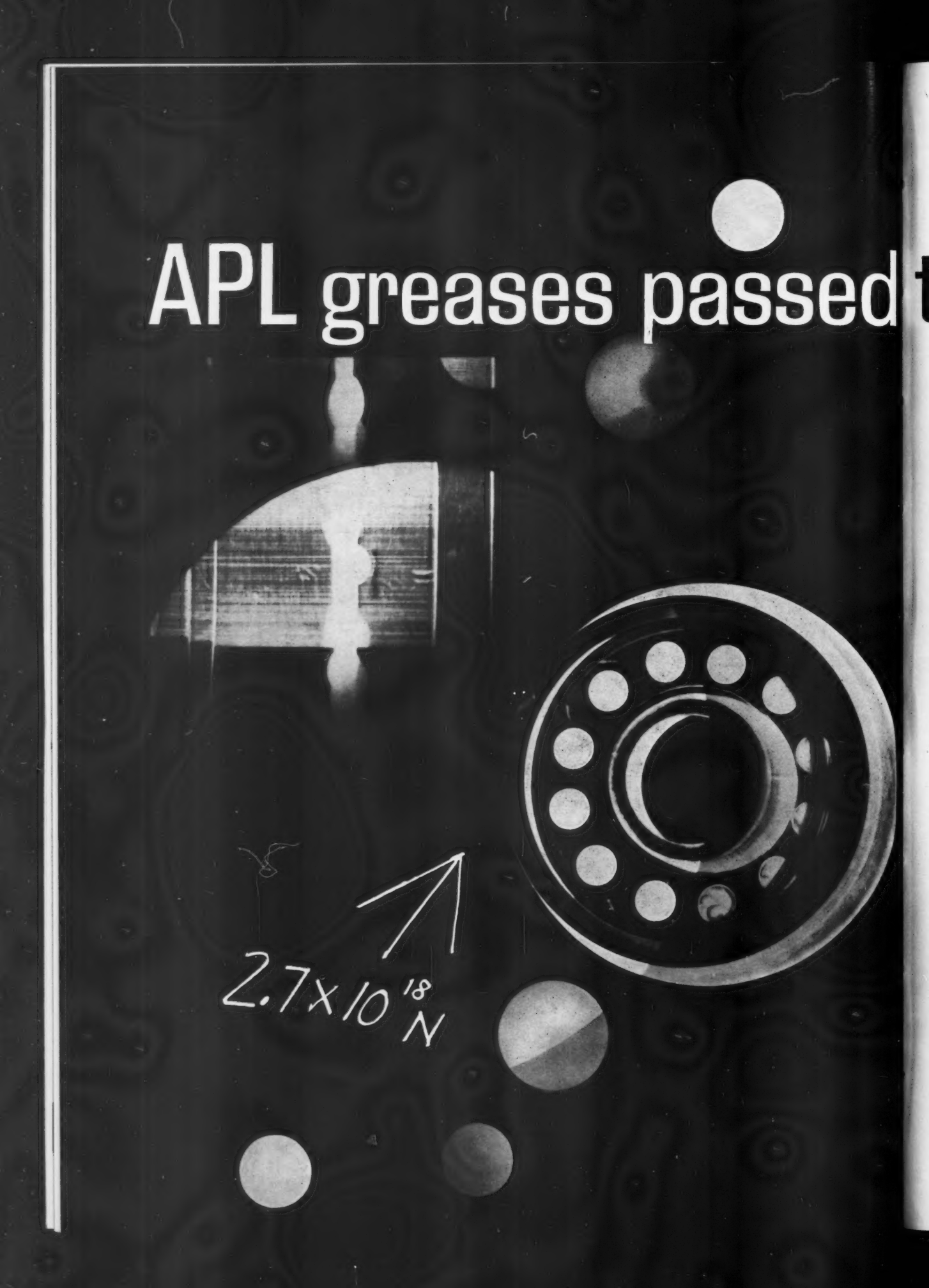
APL greases passed t



ed their finals in June...

Radiation broke up the gel structure of conventional greases. They lost their lubricating properties, turned fluid or granulated. Completely new kinds of greases were needed by the atomic power industry for the bearings situated within the radiation field.

The Shell Group started working out radiation-resistant APL greases whilst most nuclear power stations were still on the drawing-board, and the research that went into them is characteristic of the way Shell set about doing things.

A team of research workers was assembled at Shell's Research Centre at Thornton. After four years of research and testing – both at Thornton and the A.E.R.E. Harwell – APL greases were ready for their finals. A sample was packed into a bearing and sunk into the B.E.P.O. pile. There it was not only subjected to mechanical working and high temperatures in CO_2, but also to an integrated pile dosage of 2.7×10^{18} thermal N. per sq. cm. plus associated radiation. APL greases sailed through their finals – and Shell are proud of it. They should be. For with these greases, Shell completed Britain's first range of Atomic Power Lubricants.

The moral of the APL story is that Shell research is supremely applicational. The Centre at Thornton is always ready to work with even the most specialised sectors of industry to produce the right lubricant for the job. If you and your organisation have any major lubrication problem, it will pay you to get in touch with your local distributor of Shell Industrial Lubricants.

The Research Story

Naturally a whole variety of greases were investigated. Conventional metallic soap greases were affected even by relatively low levels of radiation. Other greases based on synthetic and non-petroleum materials were examined and found to be equally unstable. Some of them softened appreciably and became tacky, whilst others hardened.

The Shell APL 700 series of greases are specially processed with an inorganic gelling agent, the base lubricant used being similar to the APL oils previously proved highly resistant to radiation. There were three series of tests. First tests were preliminary radiation tests at Harwell. Then the greases were tested for their lubricating qualities in a high temperature (400°F) pressurised CO_2 anti-friction bearing rig turning at 1,500 r.p.m. For the final tests in June, actual working conditions were simulated at Harwell.

SHELL

ATOMIC POWER LUBRICANTS

another proof of Shell leadership in lubrication

The Institution of Production Engineers Journal
VOL. 37 No. 9 SEPTEMBER, 1958

Vires acquirit eundo

THE Institution motto is best translated as "We gather strength as we go". The strength of the Institution lies within its membership and it is only through the corporate activities of members that the Institution is able to advance the science of production engineering.

One of the reasons why The Institution of Production Engineers has a reputation for being a vigorous and energetic body is that a large number of members are continually serving the Institution in one way or another. Members can read Papers or give lectures on various aspects of production engineering and management; they can read and adjudicate Papers and lectures for publication; they can assist the Membership Committee by assessing theses for membership, and the Standards Committee by commenting on draft British Standard Specifications or by serving on British Standards Institution Committees; they can represent the Institution on various other bodies, such as Boards of Governors of Technical Colleges; they can review books for the Library; serve on Institution Committees, both local and national; and act as examiners or assessors for production engineering subjects for various examining bodies.

In order to provide access to the vast store of knowledge within the membership, an index of members in the United Kingdom is maintained at Head Office. One of the problems of this index is to keep it up to date. Members are constantly on the move: they change their addresses, they change their appointments, they obtain promotion, become members of other bodies, and so on. Because Head Office is not always informed of these changes, the index has become incomplete and unreliable. The Finance and General Purposes Committee have decided, therefore, that a new index should be established and for this purpose each member is invited to co-operate by supplying the essential basic information.

It would be of the greatest help to the Institution if members in the United Kingdom would be so kind as to complete as much of the detail as possible on the card which has recently been sent to them, and return it to Head Office.

Human Relations in Industry—"Men, Women and Work"

by LEWIS WRIGHT

Presented at the Production Conference, Olympia, London, 20th May, 1958

MOST people today recognise that there is a strong connection between productivity and improved living standards. Most people know that as world trading difficulties become more acute, and national crises follow each other with depressing regularity, the need to produce more efficiently and more abundantly becomes more urgent; not only to improve living standards but even to maintain existing ones.

The need for increased productivity is constantly being urged by the Government and the British Productivity Council; by economists and by a host of others, many of whom merely want the other fellow to work harder. Like human relations, productivity has become something of a band-waggon upon which all sorts of people have climbed, for devious purposes. The fact remains that if we are to maintain our living standards, much less improve them, we have got to produce more; we have got to work more efficiently. How do we propose to achieve these ends ?

new machines and new methods

The obvious way is that of capital investment in new machines. The scientist, the inventor, will continue to present us with new machines and new tools and, if the necessary capital be available, they will doubtless be used. The industrial engineer and the technologist will produce an abundance of new ideas on how to operate and improve the productivity of existing or traditional machinery. Inflation, credit squeeze and fiscal policies have over the past few years made it more difficult to scrap old machines and instal new ones as fast as national needs demanded, and difficulties exist to prevent the operation of existing machines at the optimum of efficiency. But whether we are producing by automated methods or by traditional machinery, ways must be found of getting the most out of the machine without exploiting the worker in the worst sense of the term. Whilst all the exhortations, explanations, forebodings of disaster and pleadings continue, it is industry that will have to achieve the change and it will, in most cases, prove to be a major operation, involving everyone and involving almost everything.

Stuart Chase has said: "A factory performs two major functions — the economic one of producing goods and the social one of creating and distributing human satisfaction among the people under its roof". The first of these two functions has received deep and continued attention, as indeed it should, but the second has been much neglected and generally sneered at as a sort of gimmick of long-haired philosophers. Stuart Chase goes on to say that if a factory's human organisation is out of balance, all the efficiency systems in the world will not improve output. Is the bottleneck of productivity likely to be lack of understanding ? Do we possess enough "know how" greatly to improve productivity, providing we acquire more "know how" of human reaction to innovation ?

There is plenty of evidence to suggest that too long have we neglected the human sciences, and it has taken two World Wars and a shortage of labour to cause us to recognise their importance. It is a subject of which we know so little and has, as I said earlier, become something of a band-waggon. It is inevitable that, under these circumstances, people ill-equipped to talk about them should be prepared to do so. People like myself who are not social scientists, realising the importance of the subject, are ready to exchange views and ready to learn.

the Hawthorne experiment

It is odd to reflect that this remarkable piece of investigation was undertaken by Elton Mayo more than 30 years ago; yet, probably because of a plentiful supply of labour, it has been almost completely ignored by industry both in the U.S.A. and the rest of the industrial world. What the Hawthorne investigation seemed to reveal was that there existed an element more important than the pecuniary or physical conditions of work: an element which increased output no matter what was done or not done about physical conditions.

If this be true, clearly industry must take another look at it, because it is going to help us to solve some of our problems. It will be remembered that the bare facts of the Hawthorne experiment consisted of experiments carried out at the plant of the General Electric Company in Chicago during the 1920's, when in order to study the effects of changed illumination on the production by girls on assembly work, two groups were used for comparison. In one the illumination was improved and increased, whilst in the other it was not. The output from the first group went up as could be expected, but the puzzling feature was that output in the second group, where no change had been made, also went up. The lighting of the first group was then reduced to its original standard, but oddly enough, production went up once more. It became clear that some factor unknown to the investigators was at work, and further experiments became necessary.

Two girls were selected and asked to choose another four to make up a group of *six*. The girls were assembling telephone relays and were subject to various changes of production methods. Under normal conditions, with a 48-hour week and no rest pauses, production was 2,400 relays. When the girls were put on piece-work, production increased. Given two five-minute rest pauses morning and afternoon, output again went up. Rest pauses were increased to 10 minutes each, and again output improved. The girls stopped work at 4.40 p.m. instead of 5 p.m. Output increased further. They then stopped work at 4 p.m. and output was maintained. Finally, all the improvements were taken away and the girls went back to the original 48-hour week with no rest pauses, and over the next 12 weeks whilst the experiment continued a record output of 3,000 relays a week was maintained.

Over the years, sociologists and interested laymen have drawn different conclusions from these experiments. But none would deny that any element capable of improving productivity is worthy of investigation. The conclusions drawn by Chase seem to be the most likely explanation. He suggested that by asking the girls to co-operate they had been made to feel important. They were no longer mere cogs in a soulless machine wheel, but were human beings helping the company to solve a problem. They *counted*. They had found job satisfaction. They had a clear and intelligible function to perform, and they knew precisely what they were doing and why they were doing it. In the experiment only during a portion of the time were the girls on piece-work, so that it would suggest that the feelings of the girls were to them more important than wages. As Miss Pearl Jephcott, a factory worker, wrote in 1948: "I've a hunch that we women are incurably altruistic. We've a passion to be useful — to a person. And some of us would extend this feminine vice from our private life to our job if we realised that anyone's well-being depended upon us in the national economic crisis, or even in (this) unintelligible concern". It is true that the experiment involved only women, but many similar studies revealing similar unknown elements can be found dealing with men, such as investigations into the high labour turnover of mule spinners in a Philadelphia spinning mill, and the example given by Dr. Robertson, of Unilever Ltd., concerning lighting changes in a drawing office.

When reading of Mayo's work in America during the 1920's, a trades unionist is struck by the absence of any reference to trades unions. Indeed, it is known that the General Electric Company were as anti-trades union in those days as most employers then were. It was not until 1936 - 1937, with the development of the Congress for Industrial Organisation, that workers, other than craftsmen, began to be organised and probably the lack of reference was due to the absence of anything to which to refer.

It is interesting to speculate as to what might have been the outcome had there existed a trade union

Mr. Wright is Chairman of the British Productivity Council, and General Secretary of The Amalgamated Weavers Association.

with whom the employers could have negotiated the terms of the experiment. Would communications *via* third parties have tended to vitiate the confidence generated between workers and management ? Would the desire to be part of a group have been sufficiently satisfied by trade union membership to have removed the urge to become part of something else ? It is difficult to form a conclusion, but what evidence we have today suggests that whilst trades union communications are not all that one can expect, the important part of industrial communications is within an undertaking itself, with trades unions playing a minor rôle. Once the trades unions endorse a suggested change, the really important line of communications is from top management to shop floor : up and down and sideways. I will refer more to the problem of communications later.

How do most employers and management view these human considerations ? Most of them protest that they have no time for such theoretical abstractions, and are fully occupied in producing the goods and making profit. They get some support, too, from sociologists and economists. Sargant Florence in his book " Labour " says : " There has been a tendency in American psychology, sociology, and schools of social work to concentrate on the mental attitude both of the employed and unemployed worker, quite apart from the consumer's needs or demand for his work ". I suppose the short answer to this would be : " That is the function of the psychologist and sociologist ".

But there is more to it than that. Most employers or managers haven't the faintest idea how to achieve results making for the maximum efficiency for producing for " consumers' needs and demands ". Any problem that cannot be worked out on a slide rule is dismissed as " labour trouble ", and the cure prescribed is " a dose of unemployment to bring them to their senses ", or an offer of more money. It is not impossible that lack of understanding of how to deal with human problems has made a greater contribution to inflation than is realised. In any case, and for whatever motive, a closer study of workers' mental attitudes is calculated to increase satisfaction in both producer and consumer. There is every reason to believe that in those undertakings in the U.K., where careful attention is paid to this problem, a contribution towards lowering costs results. Indeed, some of the firms have demonstrated remarkable results of increased efficiency. What puzzles most people is why, even if employers are not moralists or altruists, they do not use the advice of the sociologists as tools of management. The answer probably lies in the fact that it is no-one's job to look into this matter. Top and middle management are too busy, and the Personnel Manager is taken up completely with day-to-day problems. This is to be regretted, for much good could come to everyone if top management would seek advice as to how to approach the problem.

communications

One of the outstanding defects in the organisation of undertakings is the lack of adequate communications. Most competent firms can pass information down the line, but have no means of receiving incoming messages. Not only must links of communication go up and down, but they must spread outwards. The Works Council can help in this, but it has been discovered in many instances that information given to the Works Council is not always passed on down to the shop floor. This is especially the case where large numbers are employed, and it is impossible for the workers' representatives to pass the information round. Sometimes the facts become distorted in the passing, with unfortunate results.

At the same time that communications are sent down it is important that management should know of the workers' reaction to their conditions of employment and to their employer. Opinion surveys can prove to be a very tricky business and need the expert to draft. They can prove useful in helping management to anticipate troubles that may arise and take steps to remove the cause. I very much doubt whether any manager really knows what his workers think or feel, except in those cases of very small undertakings where management are in personal day-to-day touch with them. Most managers think they know and others neither know nor care. Benge, in his " How to Make a Morale Survey ", quotes the case of a textile mill where the manager claimed that he had his finger on the pulse of his workers and that they were one big happy family. Two weeks later the workers went on strike, damaged the machinery, and the mill closed, never to re-open. Scores of cases can be quoted to show how managers think they know what is happening, and find to their cost that they did not. The trouble with opinion surveys, and sometimes also with oral questioning, is that the truth of replies can be judged only against the background of the firm's relationship with the workers. Workers will give subjective answers when often management hope for objective answers. Not always will replies to questions convey the workers' real opinion. If the atmosphere in an undertaking is bad, the answer might be given merely to work off some other grievance. If the question is not clearly understood, a surprising answer can result. Answers in a single word of one syllable are not uncommon. But whilst it is most important for management to seek information, it is also important to give it. Last year the B.I.M. published a Report " Presenting Financial Information to Employees ". It has already been suggested earlier in this Paper that workers like to know what is going on. They like to feel they belong and they are, if not flattered, at least pleased when management takes the trouble to tell them things about the firm's activities. One would imagine that by now this might have been considered elementary. But the B.I.M. survey discloses that no more than 20% of all companies in Britain are annually giving financial information to their workers, against an estimated 46% in the U.S.A.

It is interesting to note from the survey what information workers feel is important. Almost as great a percentage were interested in costs as were interested in profits. By far the greater percentage were interested in new developments and trade

prospects, and the smallest percentage of all were recorded as being "interested only in information affecting them personally". There is little doubt that given the opportunity, workers will interest themselves in matters other than their own close personal interests, and that if given the information they will react in a responsible way. The Report emphasises that disclosure of financial data can play an important part in improving industrial relationships and joint consultations, but I must add as a trades unionist that I believe it to be reasonable also that such information should be disclosed to help in collective bargaining. The B.I.M. also drew attention (in their "Outline of Work Study") to the view that the drive must always come from the top, and that management must make it clear to all what it is trying to do. This implies, of course, that management does know what it is doing, and why. It comes as rather a shock to learn that this is not always the case. One study, details of which may be published this year, revealed that the management had no clear idea as to what they wanted, but "thought that consultants might do something". Towards what should have been the end of the operation, management realised that what was being done was not what they had thought would be done. As management had no clear idea as to the purpose of the exercise, no clear idea could be conveyed to the workers. The result was utter failure.

This temptation to put in work study and try and meet problems as they arise is not conducive to success, for problems are bound to follow in quick succession, whereas with careful thought, a little planning, and a modicum of imagination, the cause of most of the problems could have been removed at the beginning. Any contemplated change in an undertaking, whether by work study methods, new machines, or new organisation, has an immediate effect upon workers. It may or may not have a pecuniary effect, but it is bound to affect the worker in a personal way. He may have to do things in a different way. His personal relationships with people may change. The method of computing wages may be altered. Such changes can be smoothly effected only where sound communications exist, and even then great care and understanding are needed. It has been said that "resistance is not to change itself as much as it is to resentment or anxiety over the way the change is introduced". To impose change is folly. To expect change to occur smoothly without giving those most personally affected a chance to take a positive interest and part in the change is to expect too much. Adequate communication involves "putting the worker in the picture", and is the antithesis of the "carrot and the stick" technique.

redundancy

A word must be said about redundancy, or people losing their jobs. Whilst all change has a personal impact upon the workers, that of losing their jobs is the one change most clearly understood. Anxiety or resentment about changes within a worker's job cycle can be removed by explanation and by willingness to discuss the need for the change. No amount of discussion or explanation will satisfy a worker that it is in the general interest that he should lose his job. It is the one matter upon which all workers think subjectively, but upon which they are constantly being exhorted to think objectively, which to me does not make sense. Indeed, a little more subjective thinking by us all need be no bad thing. Too many people think of human factors as an obstacle to technical and scientific progress. Where they could safely be ignored, no notice has been taken of them. Progress to many has become a form of devil worship where the worker is subordinate to the machine. This has been the pattern of industrial life up to the beginning of the Second World War, but times and minds have changed, and more and more people are beginning to realise that the machine is for man, not man for the machine.

No worker can recall the inter-war years and the hunger marchers of Jarrow without a twinge of fear lest history repeat itself. Most workers cannot understand why swift progress should bring with it more misery; and something that is not understood is generally avoided or even opposed. It is true that full employment means that most people are able to find alternative employment. No responsible trades union official imagines that there will always be the same job at the same factory. There may be a different job at the same factory, or the same job at a different factory; or even a different job at a different factory. But merely to accept this as the natural industrial pattern, and to take no steps to mitigate the personal problems of workers within an undertaking contemplating change, is to make the exercise more difficult and offends against moral responsibility.

The wise employer will recognise that close joint consultation is a good thing. The problems of workers should be considered at the same time as technical changes are considered. The effect upon labour should receive the same consideration as the effect upon production. Often normal labour turnover can take care of reduced labour needs, but too often this is not even considered. Generally the technical exercise is carefully planned and then as an afterthought someone says: "I suppose we shall have trouble with the unions". Had they thought of this at the beginning, much trouble might have been avoided. It is foolish to create opponents of technical progress when it can be largely avoided. It is bad to create 20th century Luddites when there is little need to do so. If workers are treated as human beings they will, in most cases, react as human beings. Treat them as parts of an industrial machine and they will react as pieces of iron.

Sir George Schuster has written: "If man is to take the right course at the most crucial moment in the history of humanity, then it is essential not to be misled by false ideas about what science can do. Science cannot explain for him the meaning of his existence. No scientific discovery can give him a scale of values or rules to regulate the dictates of his conscience".

Nor, might I add, will any technical achievement or innovation persuade a worker that his life must become less full than it was yesterday.

conclusion

Whether we are moving towards a second industrial revolution or not is a matter of opinion. But talk of automated factories, of computing machines, and servomechanisms or "press button" production or digital computers, leads one to believe that given the available capital, technical innovation is likely to gather momentum. With it will come human problems for which we must ourselves be equipped to deal. The speed of progress is likely to be governed by the extent of our understanding of human motives and our willingness to meet the problems involved. There are signs that fear of deflation is already causing workers to think in terms of "working themselves out of a job". There are reports of certain colliery workers refusing to work overtime because, they claimed, if they did they would be out of work much sooner. This may or may not appear rational, but from a subjective point of view it is understandable why workers take action to safeguard their income for as long as possible.

We must take time by the forelock and interest ourselves in these human considerations, for upon our understanding depends so much.

Who in any undertaking is to be responsible for attempting to create such a climate ? In practice it must be a team approach, but someone at the top has first to initiate and engender the will. Each of you will know who that "someone at the top" may be. He and his staff will not find it easy. The social sciences have been so sadly neglected that not enough is known. Nor have managers much time to read the sociological works that exist.

The Department of Scientific and Industrial Research is able to give advice in these matters, and the Institute of Industrial Psychology has done some useful work. Most universities have departments of Social Studies, so that avenues of enquiry and assistance do exist.

Few of us know very much about the subject; but I am aware of the problem and recognise its importance. I very much hope you, too, will want to find out more about it.

I would like to end this Paper by quoting Stuart Chase in his book "Men at Work", because I feel that his words sum up all that I have tried to say:

> "Factory managers are going to realise that workers are not governed primarily by economic motives. Underneath the stop-watches and bonus plans of the efficiency experts, the worker is driven by a desperate urge to find an environment where he can take root, where he belongs and has a function; where he sees the purpose of his work and feels important in achieving it. Failing this he will accumulate frustrations and obsessions. For their neglect of the human functions of production, managers have paid a high price in strikes, restricted output, and a vast sea of human waste."

REPORT AND DISCUSSION

In the Chair:
The Rt. Hon. The Earl of Halsbury,
F.R.I.C., F.Inst.P., M.I.Prod.E.,
President of the Institution.

THE **Chairman** said it was his pleasure to welcome and introduce the speaker, Mr. Lewis Wright, and also Mr. E. W. Hancock, O.B.E., Past President of the Institution, in whose honour the Paper had been established.

Mr. Wright was one of those distinguished leaders of organised labour who combined the working man's point of view with a humanism characteristic of the best academic tradition. One was equally likely to find him sitting in a Conference in Paris on Automation, negotiating on behalf of his trade union, or taking the Chair at the British Productivity Council.

By way of background to the Paper, for some time the Institution had been introducing into their annual programme a number of Named Papers, honouring those who had given distinguished service to the cause of production engineering. At the meeting of the Institution's Council in January, 1958, it was announced that the long and distinguished service rendered to the Institution by Mr. E. W. Hancock would be recognised in this way.

Mr. Hancock would be familiar to all as Lord Halsbury's predecessor in the office of President. It was his wish that the invited speaker should take the subject of human relations in industry. In view of the fact that he had only recently retired as President, his occupancy of the Presidential Chair may have somewhat blurred in members' minds all the other things he had done for the Institution.

Mr. Hancock, who was Director of Special Projects for the Rootes Group and also a Director of Humber Ltd., was one of the most distinguished engineers in the United Kingdom. He was one of the far-sighted

people who saw, a long time ago, what the future held for production engineering, and he became an active member of the Institution within a few months of its foundation. He had played a continuously active part in the development of its affairs. He had served on the Council for many years, and before taking office as President in 1956, he had been Chairman of the Council from 1930 - 1932, and Past President of the Coventry Section and the Wolverhampton Section. He had always placed a great emphasis on the training of young production engineers, and it was his personal advocacy which resulted in the establishment of the Schofield Travel Scholarships in 1949.

In recognition of his services to the Institution and to the profession, Mr. Hancock was elected an Honorary Member in 1954. He was now Chairman of the Coventry Productivity Association and a member of Council of the Production Engineering Research Association of Great Britain. Such was the man who was honoured by having the Paper named after him, and who had honoured the Institution by lending his name to the Paper.

(Mr. Wright was then called upon to present his Paper, which appears on pages 532 - 536.)

Mr. Wright said he considered it a signal honour to have been chosen to give the first Paper in this series. Perhaps it was rather unworthy of Mr. Hancock's calibre, but he being interested in human factors would appreciate that it was at least the best he could do. It was intended to show an awareness of the problems.

He was speaking now in a dual role, as a lifelong trade union official, and as Chairman of the British Productivity Council. The trades union movement had for many years been concerned with the problems of human relations; obviously that was one of its main tasks, but the British Productivity Council was rather newer in the field because the basic purpose of the Council was to stimulate and encourage the better use of machinery and the use of better machinery, of new ideas, improved production methods, so that a higher output per man hour in the country might be achieved, the result being higher productivity. To do this it was sought, through the activities of the hundred or so local productivity committees and associations, to promote a freer flow of information on such matters by the exchange of ideas and experience between firms, by promoting closer relations between technical colleges and local industry and by organising in collaboration with professional bodies such as The Institution of Production Engineers, lectures, conferences and courses on new production techniques and technologies. That was one approach to the problem, a rather prosaic approach, a pragmatic approach that was clearly understandable.

Supporting the technical approach there was another perhaps equally significant part of the work, the drive to create by education, propaganda and so on, an attitude of mind throughout industry, which must make itself felt not only on the shop floor, not only among the trades unions, not only among the workers and management, but in the board room as well; an attitude of mind which would seek and support the whole concept of rising productivity and of progressive standards of efficiency, without which we would not be likely to double our standard of living within the next 25 years.

One of the means by which it was sought to promote this attitude was by encouraging a feeling, with all the information that could be obtained, of pride in industry, a feeling of pride and understanding in what was being done, in belonging to a firm who were really efficient. It sometimes must appear that in doing that, not only was an immediate purpose being served in raising productivity but an active contribution was being made to even more complex matters, to which the Paper was devoted, of human relations and social satisfactions.

The matter of pride and satisfaction in efficiency on the part not only of management, but also of workers on the shop floor, presented significant possibilities in the creation of new individual pride, in the efficiency, and power of production and the power of the whole process of industry.

If particular attention was going to be given to developing such an approach, then a little more should be learned about feeding information and understanding certain people's reactions in certain circumstances. At the British Productivity Council level, they not only encouraged the team approach, but they were a team themselves, in which management and trades unions bore equal responsibility for policy and a fair share of the task. It was largely, almost wholly, in the hands of voluntary workers; there were some 4,000 of them, employers and trades unionists, throughout the country.

The British Productivity Associations and the British Productivity Council had their job to do, and the very name, of course, did imply that they were more concerned with actual production methods, and tangible ideas by which productivity could be increased, but the Paper dealt with the intangible, with matters to which so few people had given any deep attention at all. It would be noticed that in the Paper Mr. Wright had not dealt with a number of aspects of human considerations, particularly those of machine design, for instance, which were, of course, most important, but which it was hoped would be dealt with in subsequent Papers. In this highly industrial country it was being found that perceptual vision, for instance, was playing a far greater part than it used to do. Not enough was known about that. More and more men would be required to watch dials, and visually to take in readings; when one considered what odd things happened to the human mind, it was a wonder that more attention had not been given to these matters.

There had been two occurrences recently that were apt to focus one's mind upon these problems. One was the case of the train driver, William Trew, who unfortunately was involved in a train accident in London and was eventually brought before a court. His eyes apparently saw a signal but his brain did not comprehend the signal that his eye apparently

received. A good deal of work had been done in that direction by the Medical Research Council, and they had demonstrated how fallible the eye and the brain could be. That was a case where the eye saw and the brain apparently did not comprehend.

On the other hand, "sublimal advertising" had been introduced, in which something was flashed on the television screen which the eye apparently did not see, but the brain comprehended, so there were two sets of circumstances, one almost the antithesis of the other, but each equally dangerous and about which practically nothing was known.

It was not known, for instance, what were the limits of vigilance for girls who were inspecting something like 300,000 lighter flints per day. At what stage did the inspection cease to be adequate ? At what stage in the examination of something like 1,800 zip fasteners an hour did an examiner's perceptive vision fail ? Indeed, it was more than 30 years since any real work on this subject was done. It did seem that a plentiful supply of cheap labour in America, in Britain, throughout Europe, supplied the main reason for the interest in human problems being passed over.

The situation had changed, with all parties and all governments pledged to the policy of full employment, and almost certainty that never again would unemployment such as existed between the two World Wars be seen. It was much more important that it should be found out how people reacted to given circumstances and how the best could be got out of them, not only by understanding them, but also by creating for them a deeper social satisfaction which would benefit not only themselves, but industry as well.

The Paper was a broad plea for a little more interest to be taken in social sciences. Everyone would know that the Government had realised the importance of this side of industrial work; they had set up a Human Sciences Committee under the Department of Scientific and Industrial Research and their job was to deal with the problem that Mr. Wright had tried to outline in his Paper. He said that the Paper might be inaccurate and inadequate — in fact, he was sure it was inadequate — and for one very simple reason, because he knew nothing about the subject, but he took some satisfaction in believing that no one else in the audience knew anything about it either. His plea was that they should interest themselves a little more in social sciences because it was going to mean so much in the years ahead.

Mr. Wright warned the audience that he was not an expert. The country as a whole was suffering because there had not been more experts; the social sciences had been neglected to our great disadvantage. Unless the technical and human equation could be solved very quickly, more quickly than the advent of automation, production and productivity were bound to be seriously retarded. The Paper was put forward not in isolation, but to be read in conjunction with the other Papers presented at the Conference. It was intended to be a plea for all those who had to deal with production in any form involving people, to try to understand that the people were equally as important as the machine. If the human aspects of production were neglected, it could prove to be equally as bad as neglecting the machine.

Mr. Wright hoped that some useful discussion would arise, and that people would be prepared to comment on some points whether they knew anything about them or not. He supposed it could be said that a production engineer had never been known not to comment on anything whether he knew anything about it or not, and he supposed the same could be said for trades union officials ! He was looking forward to hearing the comments, because he had agreed to present the Paper on two counts : one, because he had heard so much of Mr. Hancock's work for industry generally, and for the British Productivity Council; and, two, because he wanted to sit down and learn a lot more than he already knew.

The **Chairman** thanked Mr. Wright for making the plea for a reversal of the long neglect of social sciences. He had spent his summer holidays reading an extraordinarily interesting book about industrial society, as primitive a society as one could wish. It seemed that this primitive society threw considerable light on certain problems of labour relations in this country. Having read it with great interest, he wrote an essay pointing out the connection between problems existing in this country and problems in the tribe, and he sent it to an international journal which published Papers on the relations between science and society, but they rejected it on the ground that their terms of reference confined them to natural sciences.

Apparently science was divided into two branches, natural and unnatural, and the social sciences belonged to the unnatural branch. This was precisely the point of view that Mr. Wright had indicted, and which the Chairman also indicted.

Mr. E. F. Gilberthorpe (*Manager, Project Engineering, Bristol Aircraft Ltd.*) said he counted it an honour to open the discussion at the first presentation of an E. W. Hancock Paper. It might at first sight be thought that production engineers would be solely concerned with machines, materials, methods and so on, but the Institution had long recognised that a far more complex and involved problem, in many cases, than managing the material resources was that of dealing with, controlling, and utilising to the best advantage the human resources.

Mr. Wright had reminded the audience of this complex matter. Some would feel that fundamentally it was simply a matter of applying the golden rule, but most of the audience would know it was a far more difficult and complex matter than just that. They all shared in the general ignorance on this subject and the neglect of study of the human sciences. He thanked Mr. Wright for pointing the way to some of the approaches for solving, or at least contributing, to the solution of this intricate and involved problem. On behalf of the audience he thanked Mr. Wright for so thoughtfully leading them and at the same time sounding the clarion call to all, whatever their station and approach in industry, to

give more thought and attention to the human sciences.

Mr. E. Fletcher (*Secretary, Production Department of the T.U.C.*) thanked Mr. Wright for his Paper and expressed appreciation of the action of The Institution of Production Engineers in widening their horizons and initiating the E. W. Hancock Paper on human studies. He was glad to see Mr. Hancock present. Trades unions would welcome the increasing attention being paid by engineers to the human aspects of their subjects.

Indeed, they would probably regard it as a little belated. It was sad, Mr. Fletcher thought, that many in industry closed their ears to the subject Mr. Wright had been talking about, even though most of it was plain commonsense. Here was an interesting example of human resistance. Did we perhaps regard it as rather humiliating to be studied as a human being ? Did our cynicism stem from being childishly on the defensive ? In any event, which was worse : the resistance or the very widespread apathy ?

Here was a human problem to which Mr. Wright had not provided the answer.

There was surprising acquiescence on the trade union side to inadequate workshop conditions and inefficient machine tool controls. There was probably more danger of trades unions becoming too acquiescent than becoming too militant.

One had to look at the peculiar tribal customs of employers in the engineering industry for the reasons for their resistance to Mr. Wright's views concerning participation in industry, e.g., employer reluctance to have trades union officers in research associations. Yet research associations were faced with two problems :

(a) to discover improved methods; and
(b) to get them applied in industry.

The latter could only be done effectively on the basis of good human and industrial relationships — involving both management and workpeople.

Mr. Wright based his case on the functions of industry. With some over-simplification these were : first, to produce and develop according to national interests; secondly, to look after the consumer; and, thirdly, to provide satisfaction for those engaged in work. Their relative importance depended from case to case, and on personal value judgments. Trades unionists might be expected to put a relatively high value on satisfaction.

It was impossible to avoid the human relations factor, even with complete concentration on production, for, Mr. Fletcher argued, productivity was increased in three ways :

(a) by increased capital investment;
(b) by improved organisation; and
(c) last, but not least, by better attitudes.

When he spoke of better attitudes he did not mean " conditioning " people, nor was he talking solely about workpeople — it applied perhaps even more to management. More attention should be given to the human sciences, not so much for " trouble shooting " as to develop a healthy joint participation in the development of industry.

Mr. Fletcher said that he doubted if Mr. Wright was entirely correct when he said that D.S.I.R. was able to give advice. To what extent was this possible ? D.S.I.R. staff allocated to human sciences was very slight. Mr. Wright had also said that many British universities have departments of social studies. This was true, but what sort of advice could they give, and to what extent ? Much more weight should be given to the organisational contacts between employers, trades unions and research workers. It was no good generalising : there were already too many high-minded generalisations and slogans. For progress in this field, specific and attainable objectives were needed, which themselves necessitated a continuing association for this purpose of employers, trades unions and research workers; and the allocation of sufficient resources.

Mr. F. W. Cooper (*Education and Technical Officer, The Institution of Production Engineers*) said he hesitated to speak of university research, but there had been one interesting job done and that was an investigation into a small group of mines, when it became apparent that there was one mine that was quite efficient, and where labour disputes were very few.

One interesting fact was immediately clear, and that was that the manager of the good mine was crippled with arthritis and very much confined to his own office. The other managers spent their time darting up and down the pit solving minor troubles, and being thoroughly exasperated men. It would seem that the first manager was compelled by his physical disability to have a good organisation, to have a good system of communication, to see that every man under him knew his job, whereas in the other mines these were not apparent at all. In that same piece of research it became apparent that the larger the mine, the larger the hospital, the greater the percentage of accidents, which again was probably partially due to lack of good communications and few knew what were their responsibilities and to whom they were responsible.

He asked whether the speaker would agree that one of the first steps to be taken was a step to ensure good management.

Mr. Wright thought, with regard to the D.S.I.R., the universities and so on, that the problem was linked with the problem of communications. There was a tremendous amount of knowledge at the disposal of both D.S.I.R. and the universities, but the methods of disseminating that information was very poor. The demand for such information had been lacking, which in turn had not encouraged D.S.I.R. to undertake a communications exercise with the purpose of disseminating information over a wide field, but recently they had reached a conclusion that it was about time they took another look at their lines of communication and that in the human sciences something was done to get the information

over to industry and to stimulate industry to want to know some more about it.

It was a *sine qua non* that there must be good management if there were to be efficient undertakings; that was perfectly true. Communications played a most important part.

Sir Walter Puckey (*Past President of the Institution*) said he had just arrived back from France where it seemed to him there were only two problems at the moment worrying the French people, one being the price of carrots and the second being the shortage of potatoes. He gathered there were other problems there, judging by a few of the comments one read in the papers, but in France itself nothing seemed to matter apart from these two things. The thought occurred to him once again, as it often had in the past, how easy it was to talk of grand worldwide revolutionary movements and how easy it was to forget that most people were concerned with the simple problems connected with their homes and families and individual relationships with other people.

At the risk of being misunderstood, Sir Walter said he would like to bring the discussion down to the low level — what seemed to him to be the important level — of individual relations as distinct from the rather broad approach, which had been discussed so much in the past and again this morning.

Production engineers over the years had become rather used to the division, perhaps too sharp a division, between so-called mass production and either custom-built or individual production. He thought that these divisions were becoming apparent in the field of what he called human or industrial relations. On the one hand, there had been a great deal of talk on what might be called mass relations. On the other end of the scale, there was less and less discussion on the important aspect of the individual relations. He asked whether there was a difference between these two, whether they did not blend, whether they were not an integral part of one thing, or complementary to each other. He thought they were facets of the same problem, but felt that there was a tendency to look at human relations in the round, forgetting the very important fact that in the end it came down to personal individual relations between ordinary men and women.

Recently he had spent a great deal of time in the company of university professors, college principals, academic types of all descriptions, and he had also spent a good deal of time studying aspects of automation, and cybernetics, words which concerned the more profound aspects of communications. These studies encouraged one to look at human relations in a rather remote sense. There was also a body of research growing, containing a number of people who were rightly devoting more and more attention to social science in the sense used by Mr. Wright and Mr. Fletcher. Those things were very good but they were only good if in the end they did not deal solely with people in the mass. They started off with what engineers would call the roughing cut, but in the end the finishing cut must be applied to individual people. He wondered how good were the individual relationships between managers, and those they controlled, or were controlled by.

It was of little value to discuss communications and forget to deal with individual acts of courtesy, or consideration, which comprised the lubricating oil of human relations. His own experience was that managers were tending to forget those individual things which were much thought of by many people. There was a great danger in thinking too much of human relations in the mass social science sense, and forgetting those very simple little things which meant so much to so many. He thought it fitting on this occasion to remind those present that these personal characteristics had all his life been demonstrated by the distinguished member after whom the Paper had been named, and had played an important part in his success.

Mr. Wright largely agreed, although he thought that Sir Walter was dealing more with being polite than with being just. He agreed that a little more politeness was necessary and a little more understanding. He agreed that more attention should be given to the individual, but the fact of the matter was that workers generally were group-conscious. They themselves invariably undertook any exercise as a group, and generally speaking he thought the industrial approach had to be on a group basis.

People thought as a group and liked to belong to something, maybe freemasonry or a supporters' club, or a church, but probably everyone in the audience belonged to something or other. He considered that however good a manager might be, if he thought in terms of the individual he was heading for disaster. In Mr. Wright's judgment, management had to think as a group. Workers tended to cling together; whilst it was important that personnel should do their best to deal adequately, politely and understandingly with individuals who had individual problems, it should always be remembered that most of the problems of human reaction were group problems and must be dealt with as such.

That brought to mind the instance of a firm who had asked some industrial engineers to make a study. The odd thing was that the management had not any clear idea as to what they really wanted. They had an idea that in any case if engineers came in and surveyed the job, perhaps they could put in some work study scheme that would improve production. There was no real planned exercise. The result of that was, of course, that as management had no clear concept of what the exercise was to be, they were not able to communicate it to the operatives. Consequently both management and workers were frustrated, and the result was complete and utter failure.

It was important that management should know clearly the purpose of the exercise and that they should be able to pass it down the line clearly and understandingly.

Whilst he would agree with Sir Walter that politeness and understanding with the individual would put that individual at ease to deal with their problems adequately, beyond all that communications more

than anything else was a group exercise and had to be done on a group basis rather than on an individual one.

Mr. Whitton found himself somewhat more in agreement with Sir Walter Puckey. Whilst agreeing that one was forced today to deal in terms of groups, what must be considered in dealing with human relations and science was the technique, and care should be taken to see that there was not too much technique and not enough human relations.

When dealing with groups, the success of any discussion depended on the knowledge of the individuals, i.e., human relations between the individuals themselves. He had found that production engineers tended to spend a great deal of time deciding what would be the best piece of plant to increase production by 200%, whereas they should spend an equal amount of time deciding how they were going to sell it to the people on the shop floor. He had seen many particularly good projects fail because they had not been sold on the shop floor before they were sold to the directors.

On the subject of management and human relations, he thought there was one golden rule, to try and see the other person's point of view.

A representative of the **United Steel Central Work Study Department** said there had been a note of pessimism in the Conference with regard to human relations. He had had a very pleasing experience, which he thought would relieve this pessimism.

It concerned one of United Steel's small subsidiary companies, a company of about 250 people, producing about one-fifth of a million tons of steel, or processing that amount, where the management had not been satisfied that they had got as far as they possibly could. They asked the study people to come in on a consultative basis, and to do the job from the general works manager down to the man who swept the factory floor.

Before going into the factory, the study team had met each of the three shifts, told them who they were, and what they were doing there. During the first three weeks, they did nothing really but chat to the people, and in those three weeks, they received suggestions and ideas which had been followed up to the management. Management had made it known to the shop stewards and to the men on the shop floor that these things had been followed up. There was a potential saving of quite a few thousand pounds in three or four weeks of chatting to people. It had been made plain that they were going right through from the front office to the back door, and there had been a big uplift in morale and a colossal company loyalty.

That was a question of communications, of putting cards on the table and telling people exactly what was being done. It was being done strictly according to the book, and it was paying off.

A representative of **Pilkington Brothers** said he had noted a little challenge to British management. In the U.K. there was a rousing song, which was sung unfortunately only on the last day of the Promenade Concerts, which contained one exalting line: "This was the charter". He suggested that what was needed was more industrial charters.

He could speak from experience of an industrial charter, frequently referred to as "the shop stewards' charter", which set out clearly for management and men and their representatives the way in which negotiations should be conducted, how such things as work study groups should be discussed and settled, and how workpeople should be trained. That industrial charter was a tool of management.

Mr. Wright said he was not too sure what an industrial charter might be, but he did agree that management should try to be as clear as possible in communicating to the workers what they had in mind. He did not think the workers generally were satisfied with a schedule. It was found that they could be rather frustrated if anything was absolutely laid down and hidebound.

He thought the previous speaker got a little more towards it when he said they went on the shop floor and talked. However, Mr. Wright assured the audience that he was not advocating that management should just go on to the shop floor and talk because it needed to be set down by management precisely what they were about: they ought to try to find methods of negotiations and communication within the firm and, too, there should be well-defined lines of communication.

One of the things about industry generally was that they found it in some cases rather easier to communicate down the line and rather more difficult to obtain clear lines of communication back to the managing director's office. He did not mean that every worker should be entitled to knock on the managing director's door when he thought fit, because that would be nonsense, but he did think provision should be made down the line and up again.

Mr. Wright had a little nag at the back of his mind that what they were trying to do was to set up a schedule of behaviour. That, of course, would be fatal, because one could not have a schedule of behaviour and even if one were laid down, the very problems of human relations were such that probably it would be broken down within a week or two. He gathered what had been meant was that management should have clearly in mind what its functions were and the functions and responsibilities of those down the line from them. It should be clearly understood and communicated to workers what were their rights, how they might do things, how they might get to the managing director, and so on. Firms who did that sort of thing generally were more successful in their relationships with workers than those who left it to a haphazard sort of system or to no system at all.

One point that few speakers had mentioned was that foremen were the N.C.O.'s of industry. But the foremen did not get enough training; they were just flung into the job.

One of the problems of industry was the choice of foremen. Should management pick a technically competent man who had no idea of handling men, or a

man very competent to handle men but technically inefficient ? That was the problem that could arise, but if one had a technically efficient man, one should take steps to see that he got some training in the basic humanities, in the understanding of men and how human beings react. It was unfortunate that so many foremen appeared to be tougher than anyone else. That, he thought, was management's fault as much as anyone.

If management made it quite clear to foremen what was expected of them, and helped the foremen to equip themselves in order to deal with human as well as technical problems, it would be better for all.

On the whole, Mr. Wright agreed with what had been said, but he could not agree to the suggestion for preparation of a schedule of behaviour, because he did not think it could be done.

Mr. O. S. Puckle (*E.M.I. Electronics Ltd.*) took issue with Mr. Fletcher, who had suggested that management was not in the least interested in human problems in industry. Mr. Puckle thought that was incorrect. Of course, there were good and bad managers in exactly the same way as there were good and bad trades unionists.

Mr. Puckle's Company had given him the job of lecturing and his lectures were sometimes technical and sometimes dealt with the sort of questions that Mr. Wright had been discussing. He quite frequently talked to trades unions, sometimes to local branches and sometimes at weekend schools. His experience, resulting from observation and discussion, had taught him a great deal, but nothing like enough, about the way in which other people lived. One of the greatest difficulties, both for management and for their employees, was that neither fully appreciated how the others lived or what were their hopes, their fears and their wants. Something of vast importance to management could fail to arouse any interest in the employees, and *vice versa*. He thought a great deal had to be done to enable each side to appreciate more fully the feelings of the other.

However, he did not like the expression "the other side", because he believed that management and employees should talk as one team rather than as opposing teams, since they should have the common object of raising the standard of all concerned, viz., management, employees, customers and shareholders.

He suspected that some of the difficulties which arose in management-labour relations occurred because discussions about problems were sometimes delayed until friction had reached serious proportions. Mr. Wright, he thought, was absolutely correct in saying that, when something was going to be done, discussion should always take place beforehand, so that people could talk in a reasonable frame of mind.

A great deal of the difficulty about the introduction of automation was that various workers had fears about the results, and those fears could be set aside only by discussion and education and by making definite arrangements to avoid hardships. Some of those fears were based on fallacious arguments, but it made no difference if they were so based since, if a person had that fear, it was equally disastrous for his peace of mind whether it be based on true or false argument.

Mr. Wright thought Mr. Fletcher had implied, or said, that management was not interested in human relations. Knowing Mr. Fletcher as he did, Mr. Wright felt sure that there had been a slip of the tongue, and that he did not intend to suggest that all branches of management had no interest in human relations.

With regard to the fears founded on fallacies, workers' fears generally were not founded on fallacies at all, and that was the trouble. Generally speaking, they were founded on fact.

Most workers wanted first of all continuous employment; anything that was calculated to put them out of work for a week or two would be something to which they would react. If anyone in the audience, whatever their job or standing, were given an idea that they would lose their job next week or the week after, they would react just as violently as the workers. The main difference was that one managing director could not react as violently as 100 workers.

The fallacy, if there was one, was that too many workers felt they could always have the same job, at the same factory, doing the same thing. The trade union movement, nor any other, did not believe for one moment that in this modern world a worker could also hold the same job in the same place. There might be the same job at another factory, or a different job at the same factory, but the important thing was, that there must be a job. Any management who undertook an exercise with disregard for the worker and the job was hardly likely to succeed, except when there was a large reservoir of unemployed labour waiting outside the door.

Mr. Wright had heard the argument so often from the "logically-minded" manager who saw facts clearly, in this sort of way: "Just before the Industrial Revolution there were hundreds of thousands of horses all needing hundreds of thousands of horseshoes, and there were consequently thousands of blacksmiths. When the horses went, the blacksmiths became unemployed, but with the advent of the motor car there were 10 times as many blacksmiths needed to make motor cars".

In other words, if one could produce more cheaply, demand would be stimuated and more goods than ever would be produced. That was true, but no workers would take kindly to having a few weeks or months of unemployment in order that there should be a bigger and better job for someone else.

The one thing the working chap wanted more than anything else was a job, and beyond that, if it was at all possible, the same job. If a man had used his skill as a craftsman for 15 years and he found another job available as a street sweeper or 'bus conductor, he would not be very happy. These were not fallacies: they were the natural desire to be able to provide for a man's family.

If management would give as much attention to those problems as to problems of machinery, to investment in new machinery, to capital invested, to the layout, the sales policy and so on, then many of the difficulties would be overcome.

In France, Mr. Wright had seen a weaving mill where there were 96 Sulzer looms. Those looms, with building, cost £800,000 and would be worked by four weavers per shift. One could imagine what disaffection among those four men might do. If one or two men went off, the amortisation alone, taking 5% interest on capital and 5% depreciation, would be something in the region of £350 a day on those two items only.

This would bring more sharply into focus the situation that would arise in many places. Attention would have to be focussed not so much on labour costs, but on how to ensure that at no time were those men so frustrated for any circumstance at all that they would stop work.

For those reasons, the fears of the workers were not, in Mr. Wright's view, based on fallacy, but on fact and the experience of workers of his age and of the age of a good many of the audience, who would remember what happened at Jarrow.

Jarrow was a worthwhile exercise: it was sound, it was commonsense. Why dissipate energies over a group of yards working at 30% - 50% efficiency, when one could concentrate such work much more efficiently in one or two yards? It was a sound proposition, but when those thousands of workers were left destitute and started their hunger marches to Westminster, they must have been thinking that here was a situation in which a method of producing more efficiently and cheaply had been evolved, but in its train had come more misery and more unhappiness. That was what Mr. Wright meant by solving the technical human equation. If efficiency had to be bought at the expense of human happiness, then it seemed to him that efficiency was a bad thing.

It was the fear of unemployment, the fear of not being able to provide for the family, the fear of losing social caste, which was behind the opposition of the workers to automation, redeployment, and so on. If one could pay attention to these matters, if workers could be assumed that whilst they might not have a particular job they would have another job, and that whilst they would not suffer too much everyone would have to suffer a little, there would be a real surge forward without the opposition which had been apparent over the past years.

A representative of the **Nuffield College of Technology** supported Sir Walter Puckey, because she thought Mr. Wright had misunderstood him. Her complaint was that management would not read, although they complained about psychologists' jargon. It was for this reason, she thought, that the Hawthorne Experiment had become so famous. She sometimes felt it was high time it was dead and buried, because it was a matter of experiment with women.

A valuable person, she considered, was Mary Parker Follett, whom most people would not read because she was such hard work, but she did put over the point of view that the manager did not succeed by learning techniques, but by being a well-balanced personality. Mary Parker Follett said that possibly there were too many people in control in industry, on both sides, who were doing things not because they were efficient, but because they reasserted their own personalities by so doing.

This problem applied to engineers. Many arts graduates were going into industry as managers and this was perhaps because the engineer was afraid of human beings. She had a terrible feeling that this was true. Engineers were afraid of human beings, because human beings could be logical in a way in which a machine could not, and they were afraid that human beings would get out of control and ruin their own self-respect.

A great deal of training was being carried out for young engineers. It might be too late, she thought, to train old engineers in human relations. She asked whether the engineers in positions of authority in industry would give the youngsters who had had some training the chance to use their training, or would they say that that was stuff they got at college, which they might just as well forget?

Mr. Wright was sure he did not misunderstand Sir Walter Puckey; he agreed with what he had to say, but took the opportunity at the same time of pointing out the importance of the group approach.

With regard to the point that management should read more, he said he was not an industrial manager himself, but he found he could not read all the books he ought to read — he lived through digests.

He had the utmost sympathy with management. He thought it was one of the problems that faced most people, that management not only had to deal with the technical aspect, but also the human aspect. There might be firms organised in such a way, he thought, that the manager could spend a couple of hours a day reading, but what people would think when they went into his office and found him with his feet on the desk, reading a book which had nothing to do with whatever he was manufacturing, he did not know.

He was not at all sure that most managers had time to read. In his own industry they certainly had not and could one expect them, after an arduous day's work, to go home and read sociology? He did not know how that could be overcome.

Very often human problems were overcome by men with personality. In his own experience, he found generally that the man with personality, the man with the eagle eye, was a complete flop. The most successful man in human relations was the man who did not appear as though he could say boo to a goose. Mr. Wright did not want to see magnetic personalities in management, for they were not generally the successful types in this field.

As for engineers fearing human beings, he thought in some cases that might be so, but on the platform were Lord Halsbury and Mr. Hancock, and he thought they were living examples of people who did not fear but took notice of this aspect of the problem.

Mr. E. C. Gordon England (*Consultant*) congratulated the lady who had spoken earlier. He thought she had talked very good commonsense. He assured her that there was more chance of succeeding with the older engineers than with a great many of the younger ones, because the older engineers had learned how right was the viewpoint raised by her very pungent criticism. They had no intention of disclosing their venerability or that they had already learned the lessons which she wished to put before them. Being men, they would always cover up !

Mr. England thought they were getting bogged down very badly in secondary material, and he wanted to try to raise their thoughts by telling a little story which happened to be true. Some years previously he was asked to meet a group of 16 medical men, eminent, charming and efficient people, to whom everyone was greatly indebted. These men wanted to discuss some matters touching their profession with Mr. England and to be informed of his attitude towards these matters.

They had very kindly sent him a memorandum of what they wanted to discuss, and when he arrived at the meeting, the Chairman asked him if he would care to make an opening statement. He told them that the difficulty he was in was that he and the medical men saw things from entirely different angles — they wanted to put up "monuments" to what they imagined to be their efficiency, while he regarded all these "monuments" as the measure of their failure. He did not state this as a criticism, but as something that should be looked at factually. When they saw a new hospital going up in the medical profession, they saw it as a marvellous thing — which, of course, it was, within a very limited context — and the other wonderful things they did were also splendid — the remedial work and so on — he had no criticism of all that. But, in fact, every time they put up a new hospital and extended the medical services of this country, they were putting up further monuments to their failure.

He continued by putting to the meeting that the moral of this story applied to industry — the bigger the trades unions, the bigger the employers' federations — the greater the monuments to their failure to establish satisfactory human relations. Until this matter was looked at from that angle, and until they were prepared to make that self-examination which the situation required, there was little hope of making real progress.

Sir Walter Puckey was right, fundamentally, Mr. England thought, in what he was saying. He was expressing the view that people should be realistic and come down to earth. Mr. England thought the danger was that people were getting so wound up in all the techniques that they failed to see that the whole situation was really merely a monument to error. If one thought employers' federations or trades unions were in themselves something worthy, then industrial relations would never be got right. He did not put this view forward in that way at all, any more than he put it forward that anyone with a sense of gratitude would criticise the splendid medical people who tried to alleviate sickness and disease. What was wanted was co-operation in all ranks of commerce and industry, and what surprised him was the little effort put into looking for the causes of bad human relations. If more time were to be spent on that kind of enquiry they would find the causes, and from that logically would follow how best the causes should be dealt with.

But they must know what were the causes. The audience and Mr. England, he felt sure, could deal perfectly well with anything put forward in a clear and understandable manner and could come to sound decisions which would be to the benefit of most people, but they could only make the right decisions when they knew the causes behind any situation. A great deal of the material that had been mentioned in the Paper and discussion was remedial in character and not causative. The great advantage of The Institution of Production Engineers was that it was representative of neither senior management or trade union; they were the people who had to deal with the things that came between these forces and the members of the Institution were aware how important it was to get a new attitude of mind to bear on the situation.

He did not think the Institution needed to put on its "white sheet" over this particular matter. It had always done a sterling job of work in trying to understand causation and the Paper which they had heard was perhaps another monument to progress in this matter.

Mr. W. F. S. Woodford (*Secretary, The Institution of Production Engineers*) said he had listened, in the course of his job, to many lectures, mostly engineering or natural science, and they were usually beyond his ken, so it was an additional pleasure to listen to a lecture on "unnatural science" which came within his understanding. One of the things which most impressed him in his work was that lack of understanding which had been mentioned. It was useless to have an efficient system of communication if the language at one end was not understood at the other. He gave an example of that by quoting a story of a grandmother chiding her teenage grand-daughter: "My dear, you are always using two words I depore; they are bloody and lousy". "Am I, Grandmamma ?" was the reply, "And what *are* the two words ?"

Mr. Wright had said that he was not a manager; but in Mr. Woodford's view, of course Mr. Wright was a manager. It was apparent, therefore, that the word "manager" had at least two meanings, one for Mr. Wright and one for Mr. Woodford. How was it possible to discuss management problems unless there was a commonly understood language ?

Referring to Mr. Wright's reply to Sir Walter Puckey about the growth of group conscience, Mr. Woodford wondered if the group conscience was not the cause of a great many of the problems that existed. There were two very common expressions, frequently heard: "I couldn't care less"; and "Blow you, Jack, I'm all right". No one in the audience would have used those expressions, because it was always the other fellow who did so, but they would

all have heard them. He asked if this was not a negation of individual conscience ? He would be interested to have Mr. Wright's views on that topic, because he believed it was necessary to find out why people were saying : " Blow you, Jack " and " I couldn't care less ". It was in this field that research was needed. The failure of the individual conscience would ultimately lead to the disintegration of social order.

Mr. Wright replied that if people were kept in the dark, they would act like people in the dark; if they were kept in ignorance, they would act like ignorant people. If people did not know what they had to care about, they could not care about it, and would use the " couldn't care less " expression unless something was given to them to care about. If an explanation was given to them, it was to be hoped at least that they would try to understand, but until recent times the attitude had been " theirs not to reason why, theirs but to do and die ".

That had been the pattern of industry since Mr. Wright had been old enough to go into industry, but it was changing now. If that point of view persisted, if management felt it was only the task of operatives to perform so many given physical exertions each day and that was the end of the job, then no wonder they could not care less, no wonder they were not interested, no wonder they did not understand.

That, in Mr. Wright's view, was the basic explanation, summed up in the words with which he had started : keep people in the dark, and they will act in the dark. People in the dark were blind, and when they feared, they struck out blindly.

The **Chairman** said he had listened with much interest to the comments about the difference between treating people as human beings and treating them as individual human beings. Referring to Mr. Fletcher's reference to tribal customs, he said there might be — perhaps there were — good reasons why some people should be paid by the week, others by the month, and that others should have contracts stretching over a long time ahead, such as managing directors. However good the reason might be, they couldn't justify having at their place of employment lavatories more elaborate and palatial than anything they had in their own homes, and the short-term people having at their place of employment lavatories cheaper and dirtier than anything they had in their own homes. That was not treating people like human beings, much less like individual human beings.

There was going to be a shortage of engineers for a long time to come, and attempts to recruit women engineers were currently being made. " How should one start recruiting women apprentices ? " was a question often asked. The answer was simple. Anyone wanting to engage women apprentices must first build some ladies' lavatories. When he had pointed this out in answer to enquiries, the reaction was invariably concerned with the expense of such accommodation. People wanted women engineers, but would not provide lavatories to get them; it would cut across tribal customs.

Lord Halsbury had heard it said that the trouble about mines was the pit shaft, a bottleneck down which everything had to go and up which everything had to come, including the men; there was said to be no organisation involved in such movements — they were arranged on an intuitive basis. One would naturally suppose that the mine had a movement control section at the top and bottom of the shaft, connected by telephone. It appeared that managements did not like that sort of thing, because the men would use the telephone for passing betting slips on greyhounds. Why should they not do so ? If he was asked whether he could organise production so that the men could pass betting slips without upsetting production, he would answer : " Of course, just as morning tea is organised ". If men preferred passing betting slips to having morning tea, he would let them pass their slips. He had no doubt that some tiresome crank would say that betting was immoral, but if he were running a mine, he would not pay attention to prejudices like that.

Attempting to treat people as individual human beings was a very real problem. More than half the industrial population worked in factories employing more than 500 employees, and that line was about the line at which it became difficult for the managing director to know all the people. Below 500, one tended to know everyone, but above that one tended to know only the long-service people. He did not believe people who told him they knew everyone in a factory of 5,000 people. How could one treat people as individual human beings if one did not know them ? One had to recognise that there was a definite problem in such cases, and its solution was not obvious.

Consideration of it brought one to the problem of the foreman. They had heard that the foreman promoted from the shop floor was tougher than anyone that foreman would have tolerated when *he* was on the shop floor. The Chairman suggested that that was only because of the way in which the foreman saw the job and must derive from the fact that he had worked under a foreman who in turn had seen the job in that way.

Two caricatures of foremen were commonly recognised. One was derived from a classical work called " How to Run a Bassoon Factory ", which defined the foreman as " the man in a bowler hat who says it can't be done ". The second caricature commonly recognised was that of the foreman who thought he was there to see the workers didn't make trouble for the managers. If either of these attitudes represented reality of a situation, management could do little about it with the men. What management must do was to treat the foremen like human beings, and make it clear that they expected the foremen to treat the men like human beings in turn.

It was inevitable for everyone to have a double function : as consumer and as producer; as servant and as steward; as saver and spender. How then should we see ourselves in the context, say, of production and consumption ? As both consumer and producer. How should we see the other fellow ? Equally as one who both consumes and produces.

We were all to some extent subordinate and to some extent authoritarian, but if we always saw ourselves as authoritarian, and the other fellow as subordinate, it would scarcely conduce to good relations with him. Why did one man see himself solely as subordinate and his neighbours solely as authoritarian, instead of seeing each as a link in a chain ? One of the great difficulties in answering such questions was that we did not know enough about human psychology to be able to do so.

That was why he was entirely in accord with Mr. Wright in thinking that the social sciences had been neglected and that a great deal more attention should be paid to the facts which determined people's attitudes. He had recently been made aware of a study in a factory which had the lowest rate of labour turnover of any factory in its district, but if the men were asked what they thought about the management they replied : " They are a tight-fisted bunch of skinflints; no one stays here for the money ".

What, then, did they stay for ? They stayed apparently because the management had completely detached themselves from human relations and had very good foremen running the show for them. What the men were getting instead of money was a very substantial measure of freedom. If, when his work was finished, a man wanted to mend his motorcycle on his employer's premises, and with his employer's tools, no one pushed him around and said he could not do it. So the men were getting satisfaction in other than monetary terms.

The Chairman did not recommend that as good management, but he did suggest that if management tried to interfere with what was going on, the turnover rate would probably deteriorate.

The Chairman then called upon Mr. Hancock to speak, saying that everyone present was very pleased that he had been able to attend.

Mr. E. W. Hancock first of all expressed his thanks to the Chairman for the very kind things he had said about him, and to all his colleagues in The Institution of Production Engineers, his contemporaries and those who had passed on, who over the years had given him freely of their knowledge and advice.

He said that Mr. Wright had presented the first Paper on human relations giving a description of the points behind his words, and the way in which the discussion had developed had pleased Mr. Hancock very much. The members of the Institution were converting two dimensions into three, doing the practical conversion from the drawing board into the finished goods, and they knew only too well the importance of good human relations. They who dealt with so many specialist groups in industry knew how important it was to be personally friendly and personally associated with the various links in the chain of production, and for that reason, Mr. Hancock was delighted to hear the subject so fully discussed, sometimes out of context. It did show that there was something important which the Institution could air at least once a year.

There was no solution on this earth, as far as Mr. Hancock knew, to the human problem; he could say that quite freely. There were two things certain in this life, one being death and the other trouble. Liking human beings and believing in good human relations, it was a wonderful thing to work satisfactorily with and for one's fellow-man. They talked about factories, institutions, unions, but what were they talking about ? They were talking about human beings. They were even talking about human beings in the context of the looms to which Mr. Wright referred, which the four men could work, for *who* made the loom but human beings ?

If one wanted to produce a motor car the pressed tools alone cost £1¾ million, and other than for the great lumps of cast iron, it was all spent on employment of human beings making the tools, and human beings even cast the iron. Therefore, if they looked at the problem in that way, and realised that the human beings were the prime movers, they would get further towards reducing the problems.

The habits and behaviour of human beings must be studied. He had noticed a typical habit at the present meeting, in that all the front seats were empty. If the Chairman had put pressure on the audience, they would have moved forward and everyone would have heard much better. But the Chairman very wisely did not tell the audience to go and sit in a place not of their own choice, because had he done so, the meeting would have been started with a feeling of frustration and of being pushed around. Knowledge of human behaviour and habits led to a knowledge of human relations. The *cause* of the trouble was the important point to be considered in the more scientific approach to the problem.

The British were the most educated race of people in the world, and yet they often found themselves in the middle of the silliest type of situation where people would say that they would not do such-and-such a thing and someone else would say : " Well, if you don't, I'm not going to ", and the whole machine would stop because everyone was so interdependent and could not go on working on their own. Somewhere there was a point in time where men, if only they had got together, if only they had a little more scientific knowledge as to what might happen if they did this or that, could have solved the problem before it became disaster.

What happens ? A few people sit round a table and solve the problem too late with loss of goodwill. Why was it not done before ? Everyone had to learn and that was why Mr. Hancock was so pleased that they were talking about human relations in industry, by so many people *in* industry.

There was one fact in the Paper that Mr. Hancock wanted to stress. Everyone must think in terms of change; all had to be much more flexible in their approach to change. Production and planning engineers had to plan for the human change in their new activity with new methods and machines. The trades unions had to do likewise. There were over 600 trades unions in the U.K. and in an industry such as the motor car industry there were at least 14 different unions working together in one factory. In these circumstances, when one wanted to make a

change, there were many problems. Mr. Hancock had experienced an occasion when he moved a man and everyone refused to work with him, a fully skilled, craft trade unionist. Why ? Because he was in the wrong union; that was all. One would have thought he was a man from Mars, not a brother in a trade union.

Management of the unions and management in the factory had all during the kaleidoscope of change to study the problem, to try and find out how they could, in their small units, get together as individuals, discuss the problem, and then make the change in harmony.

The Chairman was to be congratulated on the fact that they had had two leading trade union executives taking part in the discussion, as well as prominent industrialists. Mr. Hancock thought that showed that the Institution was making further progress, and he was deeply grateful to the Institution for naming the Paper after him, and to the Chairman for giving him the opportunity of expressing his feelings.

Mr. Wright, in concluding his remarks, said it was true, as had been pointed out by many speakers during the meeting, by the Chairman and by Mr. Hancock, that little was known about the problem of human relations. It was not perhaps the job of production engineers to be social scientists, but he wanted to see more social scientists trying to find out why people reacted in certain ways. They reacted very queerly, and it was always found upon investigation that there was some reason, and had it only been known, the reaction would have been avoided. What he had had to say had not been intended to suggest that everyone should rush off and try to get a degree in some of the social sciences. The job was purely one for the social scientists, and he was looking to them. What he was suggesting was that they ought to be encouraged, more should be done to encourage their work and to find out what they were writing about, to find out what they had to tell, because he felt sure that if that was done, if a greater interest was taken in the social scientists, if there were more social scientists to try and diagnose the problems, then the circumstance Mr. Hancock had mentioned about the trade unionist would not recur. More than half of their difficulties could be solved before they ever presented themselves.

The **Chairman** thanked Mr. Wright and Mr. Hancock for the contributions they had made, and all the other contributors who had made the discussion so valuable.

The proceedings then terminated.

"PROPERTIES AND APPLICATIONS OF HIGH ALUMINA CERAMICS IN INDUSTRY" —

concluded from page 559

mechanical (Fig. 15)

The main features in these applications are the ability to withstand high temperatures and maintain mechanical strength, resistance to abrasion and chemical attack, and hardness.

General. Argonarc welding shields; mechanical seal faces; pump cylinders and plungers for chemical and abrasive fluids; mechanical parts working in corrosive atmospheres; high temperature bearings; wear resisting parts for use in the mining and oil industries.

cutting tools (Fig. 16)

Certain sections of the Press have made exaggerated claims for ceramic tools, but they are now established as a commercial proposition and have entered a period of intensive development arising out of experience gained in industry. They will be in two forms: throw-away tips, indexible and not requiring regrinding, and "tipped" tools, the tips being fixed to the shanks by brazing or cementing. Considerable work has yet to be done on the application of ceramic tools as regards tool geometry and machining conditions. The main attractions of ceramic tools are:

cost;
availability of raw material;
safety in certain applications, being non-sparking;
non-metallic and therefore good for machining electrical insulating materials.

The ceramic tool has not yet reached the stage where it can be sold 'over the counter' and more operator education will have to take place before this is so.

nuclear application

It seems that these materials will play an increasingly important part in these applications. A great deal of work is at present being done on the effect of radiation on them and preliminary results are encouraging.

textile (Fig. 17)

The attraction of the material is its wear resistance and hardness. The principal uses are for thread guides and tension devices. The use of this material for guides has arisen from the abrasive nature of the man-made fibres and filaments (viscose, acetate, nylon, Terylene, glass, etc.) and certain natural fibres such as jute, which cut through even hardened steel guides under certain conditions. The resistance to acid attack is an advantage in certain wet processes. The main difficulty in replacing the old porcelain guides on machines previously used for natural fibres and now processing artificials, lies in the almost fantastic shapes of some of the guides. However, by modifying the design of the guide, it is usually possible to produce one in high grade ceramic which will perform the same function as the original with longer life due to increased wear resistance and mechanical strength.

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properties and applications of high alumina ceramics in industry

by F. E. V. SPENCER, M.I.Prod.E., and D. TURNER

A Paper presented to the Leicester Section of the Institution, 13th March, 1958

PROGRESS in industrial technology is increasingly dependent on the availability of improved materials of construction. In the ceramic field, as well as in the metallurgical and plastic industries, important new products have been developed to meet this challenge.

Ceramic materials have traditionally been manufactured from clays mixed with other mineral additions. The plasticity of the clay facilitates the shaping of the required article and the subsequent firing process hardens and stabilises the structure. During the firing process reactions between the constituent materials, together with chemical and physical changes in their form, take place. Liquid eutectics are formed and provide a glassy bond between the crystalline components. The molten fluxes gradually dissolve many of the primary crystalline components and, in turn, secondary crystal phases are thrown out of the supersaturated solution. In general, these processes do not proceed to completion and the fired structure is necessarily a heterogeneous mixture of crystalline materials bonded in a glassy matrix.

The physical and chemical properties of these traditional ceramics are particularly susceptible to the amount and composition of this glassy phase. In many porcelains the glass content is vital to provide a non-porous structure and thus render the body impervious to moisture, but many properties such as refractoriness and the electrical characteristics at elevated temperatures may be adversely affected if appreciable amounts are present.

In the manufacture of certain specialised technical ceramics, particularly for sparking plug applications, it became necessary to develop a much more homogeneous and consistent product and to eliminate, or substantially reduce, the fraction of glassy phase. Success was achieved by using a new concept of ceramic production. Simple inorganic compounds such as the metallic oxides were substituted for clays and other materials as the basic ingredients. New methods of processing similar, in some respects, to the sintered metals techniques, were introduced and firing at somewhat higher temperatures became essential. In many of these new ceramics a single basic ingredient is used and such products are called "one compound ceramics". The most outstanding and widely used of these is sintered alumina.

The physical and chemical properties of this material show a remarkable improvement on those of the older ceramics. The absence of low melting point eutectics ensures high refractoriness. Mechanical strength is exceptional, because internal stresses due to differential thermal expansions between a number of differing components is eliminated, and the complete homogeneity of the ceramic results in a very high thermal conductivity and very favourable electrical characteristics.

pure sintered alumina

Sintered alumina is produced by compacting very finely ground aluminium oxide and firing this to a high temperature. The usual raw material is a calcined aluminium hydrate prepared from bauxite by the Bayer process. Being an intermediate stage product in the manufacture of metallic aluminium, the oxide is commercially available with a purity well over 99%. Its melting point is approximately 2040°C but, by suitable production methods, it is possible to obtain from this simple single ingredient a hard dense ceramic material, consisting of a mass of interlocking crystallites free from interstitial glass at firing temperatures below 1800°C.

Basically the procedure differs from traditional practice in two respects — the shaping of the initial form and the mechanism of the firing process.

shaping methods

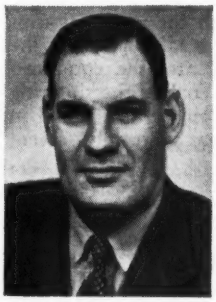
Alumina crystals have normally no plastic properties, although Otto Ruff [1] showed that, by extremely fine grinding and subsequent acid treatment, it is possible to produce a modified surface condition (wasserhülle) which does confer a certain degree of plasticity. This comminuted material can be prepared as a liquid slip and 'cast' in plaster of paris moulds. The extraction of the water content by the plaster leaves a semi-dry shaped mass which can be removed for firing.

It is also possible to form simple shapes by tamping moist powder but, in general, it is necessary to add organic plasticisers which will bond the material during compaction, but which will be completely removed during the firing of the ware. The addition of thermoplastic or thermosetting plastic powders, followed by the use of the standard press methods of the plastics industry, has been successful. Alternatively, admixture with starch pastes, waxes or similar additions allow the preparation of a granulated mixture which can be formed by die pressing or by hydraulic pressing in flexible rubber moulds. Much greater uniformity of compaction is possible by the latter method. Extrusion processes are satisfactory for the production of rods and tubes, but again, the addition of plastic organic materials is almost invariably required.

sintering and the firing process

During the initial processing the powdered oxide is usually reduced to a grain size below 10μ diameter. Indeed it is often necessary to include an appreciable percentage of material less than 1μ. The resultant surface area is very high and the excess free energy of the crystal surfaces, combined with the intimate contact established between them during consolidation and forming, are the factors necessary for initiation of the sintering and recrystallisation processes which take place during the firing cycle. Initially the interfaces of adjacent crystals adhere as a result of atomic forces, thus leading to a reduction in surface energy and a more stable system. Even at relatively low temperatures considerable hardness and strength is developed in the material. As the firing sequence proceeds a recrystallisation of the whole body has taken place. The fired ceramic is a closely packed mass of interlocking crystallites, free from voids except for minute gas bubbles entrapped during the growth of the new crystal network. At this stage, when a uniform fine grained structure has been produced, the optimum physical properties of the sintered alumina are reached.

★



Mr. Spencer was educated at King Henry VIII School, Coventry, and Market Bosworth, Leicestershire. He served an apprenticeship at the G.E.C. Telephone Works, Coventry, from 1930 - 1935, *and in* 1936 *was appointed Departmental Supervisor.*

In 1940, *he took up the position of Production Manager, V.H.F. Radio Assembly Equipment, G.E.C., Bradford, and five years later went out to Calcutta as Works Manager of the G.E.C. factory there.*

Mr. Spencer returned to the U.K. in 1950, *as Assistant Works Manager of the G.E.C. Telephone Works at Coventry, and in* 1954 *became Works Manager of Lodge Plugs Ltd., Rugby. He was appointed to his present position as Works Director in* 1956.

Mr. Turner received his education at the University of Sheffield and in 1921 *joined the Scientific Staff of the National Physical Laboratory.*

In 1935 *he joined Lodge Plugs Ltd. as Chief Chemist, and was appointed a Director in* 1956.

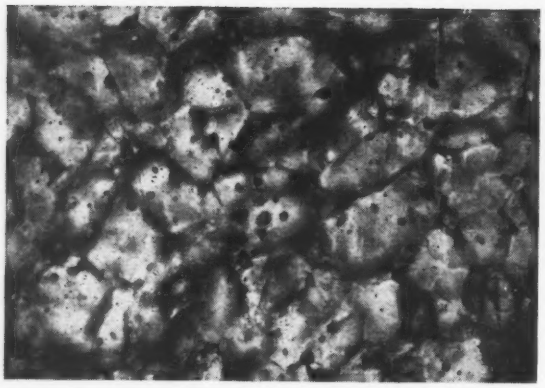


Fig. 1(a)

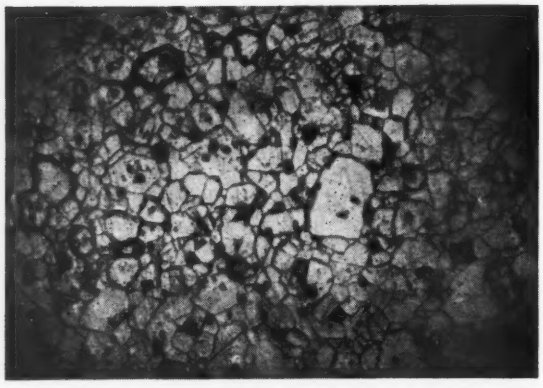


Fig. 1(b)

Structure of a typical pure sintered alumina

The structure of a typical pure sintered alumina is shown in the micro-photograph (Fig. 1) which also illustrates the gas bubbles within the individual crystals. The absence of any glassy phase will be noticed and it is important to realise that the strength of the atomic bond between the crystals is such that, under stress sufficient to produce breakage, intra-crystalline as well as intercrystalline fractures will often be observed.

In parallel with the recrystallisation process grain growth in the crystals will proceed and the firing operation must be regulated by suitable control of the time-temperature relations. The use of excessive temperature or time of heating almost invariably results in rapid and irregular grain growth and the presence of isolated large crystals may introduce serious structural defects. Ryschkewitch [2] states that two to three hours treatment at 1900°C will produce a 10-fold growth in crystal size.

During the firing process the original pore spaces of the formed compact are eliminated, resulting in a large increase in bulk density. This necessarily means that the volume shrinkage is considerable as is illustrated in the photograph (Fig. 2) of the same sparking plug insulator before and after firing. The graph (Fig. 3) shows how the linear shrinkage increases during the progress of the heating cycle and the onset of the recrystallisation process. It is obvious that uniformity in compacting pressures and careful control of the firing operation are essential to avoid warped or defective ware.

One other method of preparation, known as hot pressing, may be briefly mentioned. Here the prepared powder is contained in a graphite die which is heated electrically, either by high frequency induction or normal resistance principles. With the application of pressure the shaping of the article takes place at the same time as the firing process, and the combined application of heat and pressure enables the sintering to be completed at much lower temperatures and in shorter times. The method has naturally severe

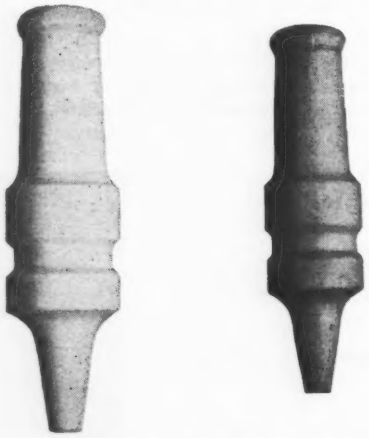


Fig. 2. An illustration of volume shrinkage

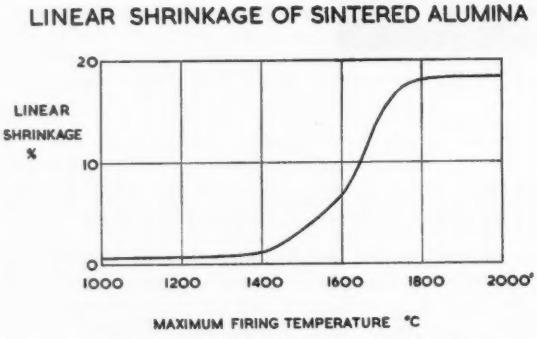


Fig. 3. Graph showing progress of linear shrinkage

limitations and some contamination from the graphite is almost inevitable, but it is claimed to be successful for certain applications.

debased alumina ware

Firing temperatures exceeding 1750°C impose a severe strain on furnace refractories. Furnace life is seriously reduced and operating costs are excessive. The sintering process can, however, be accelerated (probably due to the initial formation of a liquid phase at the interfaces of the crystals) and the firing temperature reduced by up to 250°C by the addition of small percentages of fluxes or "mineralisers" during the grinding of the raw alumina. If these additions, such as lime, magnesia, silica, zirconia and similar materials, are carefully chosen and if the firing cycle is suitably adjusted, no appreciable amount of glassy component is introduced into the fired structure.

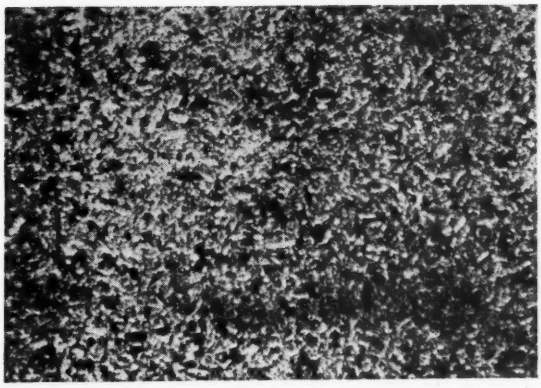


Fig. 4. Micro-photograph showing structure of 95% alumina ceramic

	'Sintox' Ceramic	Porcelain	Steatite
Ultimate Strength lb./in.²	18,300	4,250	8,000
Youngs Modulus lb./in.²	46.7×10^6	—	—
Compression Strength lb./in.²	240,000	110,000	120,000
Modulus of Rupture lb./in.²	48,400	14,000	18,000
Specific Gravity	3.72	2.4	2.6
Mean Coefficient of Linear Expansion per 1° C. ... ... 0— 200	6.3×10^{-6}	4 to 6×10^{-6}	8×10^{-6}
0— 400	6.9×10^{-6}	—	—
0— 600	7.4×10^{-6}	—	—
0— 800	7.8×10^{-6}	—	—
0—1000	8.1×10^{-6}	—	—
Thermal Conductivity C.G.S. Units (Comparative Steel	.054 .115)	.0024	.0035
Specific Heat C.G.S. Units	.175 @ 25°C	.25 @ 500°C	—
Temperature Limitation according to application	1,400°C	—	—
Dielectric Strength 50 cycles KV/Cm.	480	275	200
Impulse	820	—	—
Dielectric Constant ... ... 1 Kc.	10.0	—	—
1 Mc.	9.6	5.6	6.0
1,000 Mc.	8.54	—	—
3,000 Mc.	8.2	—	—
10,000 Mc.	9.2	—	—
Power Factor ... ... 1 Kc.	.008	—	—
1 Mc.	.0006	.0055	.0021
1,000 Mc.	.0003	—	—
3,000 Mc.	.0004	—	—
10,000 Mc.	.00070	—	—
Volume Resistivity Ohm. Cm. ... 14°C	10^{16}	10^{13}—10^{14}	10^{14}—10^{15}
100°C	2×10^{15}	—	—
200°C	4×10^{14}	—	—
300°C	3×10^{13}	10^6—10^7	10^8
Temperature Coefficient of Capacitance per °C at 1 Mc. (10° to 65°C)	$+ 125 \times 10^{-6}$	$+ 450 \times 10^{-6}$	$+ 280 \times 10^{-6}$

Fig. 5. Physical properties of "Sintox" ceramic compared with porcelain and steatite

It is also possible, by proper choice of the additives used, not only to regulate the recrystallisation process, but also to control the extent to which grain growth will take place. Thus the properties of these modified alumina ceramics (with certain exceptions such as refractoriness) can still equal and in some respects excel those of the pure material. Debased alumina ceramics usually contain about 95% alumina but, where the highest quality is not required, compositions down to 85% alumina are sometimes used. The photograph (Fig. 4) shows in a micro-section the homogeneous, well-balanced fine-grained structure and the absence of interstitial glass which can be attained in a 95% alumina ceramic. Such compositions frequently contain small quantities of highly plastic bentonite (Montmorillonite) as a source of silica and, in some cases, more conventional shaping methods are then possible.

properties

As would be expected, the properties of commercially available sintered alumina materials vary appreciably according to their composition and the particular manufacturing process which has been employed. Indeed, it is often possible to introduce limited modifications in these properties to suit particular applications. It should be emphasised,

Property	Unit	85% Al_2O_3 Vit. Body	95% Al_2O_3 Vit. Body	99.5+Al_2O_3 Vit. Body	99.5+Al_2O_3 Porous Body
Tensile Strength	P_{si}	17-23000	25-35000	37500-38000	——
Compressive Strength	P_{si}	140,-400,000	250,-400,000	427,000	10-125000
Flexural Strength	P_{si}	30-45000	45-50000	42700-47000	10-22000
Modulus of Elasticity	P_{si}	31-35 x 10^6	39-43 x 10^6	52 x 10^6	——
Impact Resistance	Inch-Pounds Charpy	5.8-7.0	6.2-7.6	——	3.0
Specific Gravity	——	3.40-3.53	3.61-3.75	3.7-3.97	2.4-3.40
Water Absorption	Per cent	0.00-.02	0.00	0.00	7-1.8
Porosity	Per cent	<1 Gas Tight*	<1 Gas Tight*	<1	$7\frac{1}{2}$ ——
Hardness	Moh's Scale Knoop	8.5-9 1450	9 1720	9 ——	—— ——
Maximum Working Temperature	°C °F	1300-1400 2200-2550	1600-1700 2910-3100	1950 3542	1400-1800 2550-3270
Pore Size	Microns	——	——	——	2-3
Specific Heat	BTU per lb. BTU/hr/ft²/100° BTU/hr/ft²/800°	0.180 90-116 180	0.188-0.190 130-150 240	0.22 135 ——	—— 116 ——
* Helium mass spectrometer test on 0.010" sections					
Thermal Conductivity	°F/in.–1600°	230	300	——	——
Thermal Coefficient of Expansion °C	25-200° 25-600 25-700 25-800 25-1000	5.47-5.68 x 10^{-6} 6.55-6.96 7.6-7.9 7.33 7.67-7.89	5.7-6.67 x 10^{-6} 6.7-7.65 8.08 7.6 8.45-9.14	—— —— 7.7 —— 8.4	5.1 x 10^{-6} —— —— —— ——
Thermal Shock Resistance		Fair	Good	Good	Good
Dielectric Strength Volts/mil AC	25°C 500°C 1000°C	205-350 —— ——	250-400 100-120 20-30	380 —— ——	50 —— ——
Volume Resistivity ohms/cm²	25°C 100°C 200°C 300°C 400°C 500°C 600°C 700°C 800°C 900°C	1-3.6 x 10^{14} 2-7.5 x 10^{13} —— 1-5.0 x 10^{10} —— 1 x 10^8-7.5 x 10^9 —— 3-7.0 x 10^6 —— 4-5.0 x 10^5	10^{16} 9.0 x 10^{14} 10 x 10^{13} 5.3 x 10^{12} 10 x 10^{10} 1.2-4.5 x 10^{10} 10^8 6.0 x 10^8 —— ——	—— —— —— 1.2 x 10^{13} —— 1.3 x 10^{11} —— —— 3.5 x 10^8 ——	10^{14} 8.5 x 10^{13}-1 x 10^{14} —— 1 x 10^{10}-1.5 x 10^{11} —— 7.5 x 10^7-1.0 x 10^9 —— 3.6 x 10^6-3.0 x 10^7 —— 5.6 x 10^5
To VALUE °C		750->1000	800->1100	1100	835->1100

Fig. 6(a)
Physical properties of high alumina ceramics

however, that sintered alumina must now be considered as a precision engineering material whose properties are controlled and maintained to a high degree of consistency and which, largely due to the particular requirements of the electrical and electronic industries, can now be supplied to a dimensional accuracy far removed from that associated with the older ceramics.

The table in Fig. 5 gives published figures for the properties of a pure sintered alumina and Figs. 6(a) and 6(b) shows similar figures for a 95% alumina body showing also comparative values for typical porcelain and steatite products. The figures for the mechanical properties of the debased material represent average values obtained from the normal type of test specimen. Those for the pure material are the highest readings obtained from particular sizes of test pieces designed to furnish maximum results for theoretical evaluation.

It will be seen that the tensile, flexural and compressive strengths are greatly superior to those of other ceramic materials. Good mechanical properties are also maintained even at relatively high temperatures. Figs. 7 and 8 show the variations in tensile and compressive strengths of pure alumina with rise of temperature.

The specific gravity of pure alumina bodies lies between 3.8 and 3.9, but this value falls progressively as the alumina content is reduced. The material has zero porosity and is usually impervious to gases even in thin walled articles.

Thermal conductivity is exceptionally good and approaches that of some metallic materials. This, combined with the high mechanical strength, gives these materials appreciable resistance to thermal shock in spite of a relatively large thermal expansion and a high value of Young's Modulus.

The remarkable resistance to abrasion and the hardness of sintered alumina will be mentioned later. Neither of these properties can readily be defined in the usual units, although a rough assessment of hardness is given by a value of 9 on Moh's scale.

For use in refractory applications, the working temperature is dependent on the alumina content of the product. Under favourable conditions pure alumina may be used at temperatures exceeding 1800°C, but low alumina content materials are usually not suitable above 1300°C.

Sintered alumina, because of its dense glass-free structure, possesses a high degree of chemical inertness with consequent resistance to the attack of most chemicals. The pure material withstands the action of both acids and alkalis for prolonged periods. The debased materials though slightly less resistant are equally suitable for many chemical applications.

Property		Vit. 85% 25°C	Vit. 85% 500°C	Vit. 95% 25°C	Vit. 95% 500°C	Vit. 99.5+%	Porous 99.5+%
Dielectric Constant	60 cycle	8.4		9.2			
	1×10^3 (1kc)	7.65-8.75	13.86	8.84-10.51	13.3	10	
	1×10^6 (1mc)	7.4-8.95	8.87	8.81 9.60	9.03		5.5
	1×10^8	8.10-8.95		8.80 9.60			5.3
	1×10^9			8.60			
	3×10^9	8.14		8.80			
	1×10^{10}	8.08-8.77	8.26	8.40-9.36	9.03		7.07
Power Factor Tan δ	60 cycle	.0013-.0015		.0005			
	1×10^3	.0002-.0014	0.580	.00007-.0006	1.1		
	1×10^6	.0007-.0012	.024	.00035-.0035	.012		.0005
	1×10^8	.0009		.00035-.0040	——		.0005
	1×10^9	——		.0006			
	3×10^9	.0014		.0010			
	1×10^{10}	.0027	.0033	.0008 .0015	.0021		
Loss Factor	60 cycle	.011-.013-					
	1×10^3	.00175-.0115	8.0	.0008-.0053	14.6		
	1×10^6	.0018-.0078	.21	.0014 .0035	.108		.003
	1×10^8	.006-.0074		.0031 .0040			.003
	1×10^9	.0076		.0038			
	3×10^9	.0114		.0080			
	1×10^{10}	.013-.0218	.027	.0067 .0140	.019		.00075

Fig. 6(b). Electrical properties of high alumina ceramics

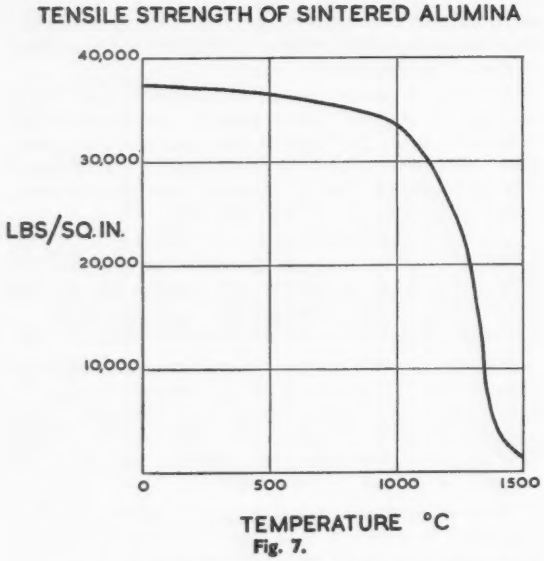


Fig. 7.

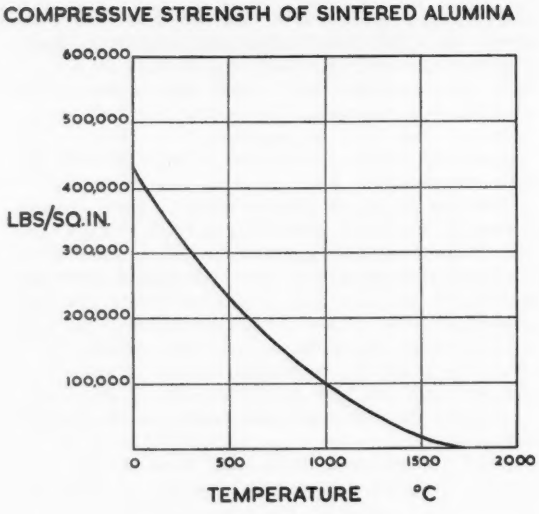


Fig. 8.

Variation in tensile and compressive strengths of pure alumina with rise of temperature

As an electrical insulating material even at high temperatures sintered alumina is exceptional. Volume resistivities as high as 10^8 ohm/cm. at 800°C are quoted. It has a very high dielectric strength and the power factor is very low at all frequencies.

In conjunction with the mechanical and thermal properties, which have already been mentioned, these electrical properties ensure a wide variety of commercial applications, a number of which will be described later in the Paper.

Manufacture of Sintered Alumina Bodies

As previously mentioned, the main methods of manufacture of sintered alumina parts are extruding, pressing and slip casting. The selection of the best method of manufacture generally depends on the shape and quantity required. Long cylindrical articles where the diameter is smaller than the length are better extruded, whereas large quantities of articles which are the reverse and do not have any undercuts in the external or internal shape can with advantage be pressed. Slip casting is a very much slower process, but extremely useful for production of elaborate shapes which are uneconomic to produce by any other means. In all cases, the quantity required will have a considerable bearing on the economics of tooling and consequently the method, exactly as applies in the production of articles in wood, metal or plastics. The smaller the quantity required, the more machining operations will be necessary to produce a finished article.

Whatever process is chosen, there is a complicated material preparation stage prior to any actual operation. It is therefore proposed briefly to go through the method of material preparation.

The first operation in the material preparation is the mixing of the various ingredients and milling to the correct grain size. This is done in suitably lined ball mills comprising a steel cylinder which may be up to 6 ft. in diameter and 5 ft. long ; the cylinder is mounted on horizontal bearings with a drive unit to enable the cylinder to be revolved at speeds of approximately 14 r.p.m. The cylinder is loaded with a charge of aluminium oxide and other additives, an amount of cretoids (these can be cylindrical, spherical or irregular in shape) and water, the total charge weighing up to 7 tons. The operation of milling relies on the tumbling action of the cretoids grinding the powder down to the appropriate grain size, and it is quite conceivable that it may take up to three days' continuous running to achieve the correct mesh size. The internal lining is necessary to prevent metal contamination.

After the usual quality control check, the material is pumped through the stainless steel mesh screen into a large tank, the stainless steel screen being used to separate the cretoids from the 'slip' which is the term used for the resultant creamy-like liquid. The large tank serves as a reservoir for a number of mill charges and material is continually stirred by paddles so that the contents are mixed sufficiently for a consistency to be obtained throughout every batch. Material prepared up to this stage is used for the slip casting process and pressing which will be described later.

For other processes the slip is pumped to a pressure vessel subject to 120 lb./sq. in. for delivery to filter presses (Fig. 9). These comprise a number of concave section cast iron plates approximately 24 in. square in a horizontal clamp frame, between which are double

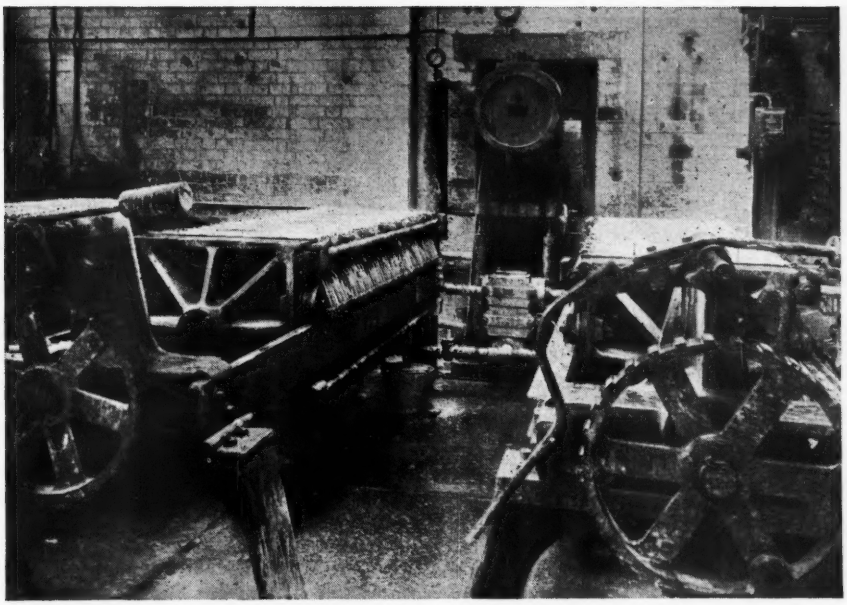


Fig. 9. The slip is pumped to a pressure vessel for delivery to filter presses

hessian and finely woven nylon filter cloths (Fig. 10). The slip is pumped through the filter cloths, the water being extracted, leaving in the cavity between the plates flat cakes of material of a plasticine texture. After the majority of the moisture has been removed, the press is opened, the cakes extracted from between the plates, placed on expanded metal trays and baked in an oven at 53°C for 1½ hours. This is to remove further moisture without completely drying them.

The material for extrusion continues further through the process and is fed into a pug mill, the principle of which is a worm feed which shreds the material and feeds it into a vacuum chamber. Within the vacuum chamber is a further worm running in the opposite direction, the vacuum being there to remove any entrapped air. The pressure of the worms forces the material through the nose to produce a continuous flow of material about 3 in. in diameter. This is cut off into convenient lengths of about 24 in. and these are then fed into a second pug mill machine for a repeat of the previous process to ensure a complete homogeneous mix. The material is then stored for at least 24 hours in controlled temperature and humidity conditions, after which it is ready for extrusion.

When the method of manufacture is by pressing or compacting, it is necessary to have the material hopper fed and to give the material suitable free-flowing properties, the method adopted is to spray dry. This involves a large cylindrical vessel in the centre of which at the top is a rotating disc beneath a small orifice. Ceramic slip is pumped through this jet orifice at a controlled rate. The droplets fall on to the rotating disc and are spun by the centrifugal force. At the top of the large cylinder controlled heat is applied so that the droplets of slip, as they are flung through the heated atmosphere, lose their moisture content and arrive at the periphery vessel as a controlled sized spherical granule. These fall to the bottom and are collected in a container. As a result of their spherical shape, they are very free-flowing and suitable for feeding into press cavities.

subsequent machining operations

If it is decided that the method of manufacture shall be by extrusion, raw material is taken from stock in pugs 24 in. × 3 in. diameter and put through a similar extrusion process to the one previously mentioned (see Fig. 11) except that it can have the addition of a core pin which will produce articles with shaped parallel external and internal bore. The most usual form is cylindrical, round, square,

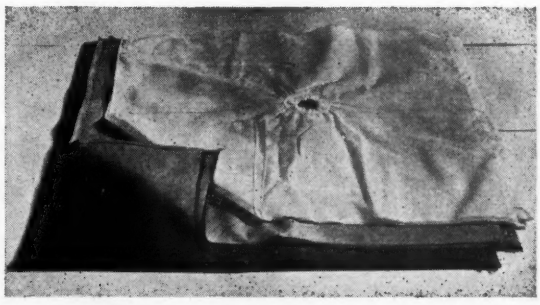


Fig. 10. Filter cloths

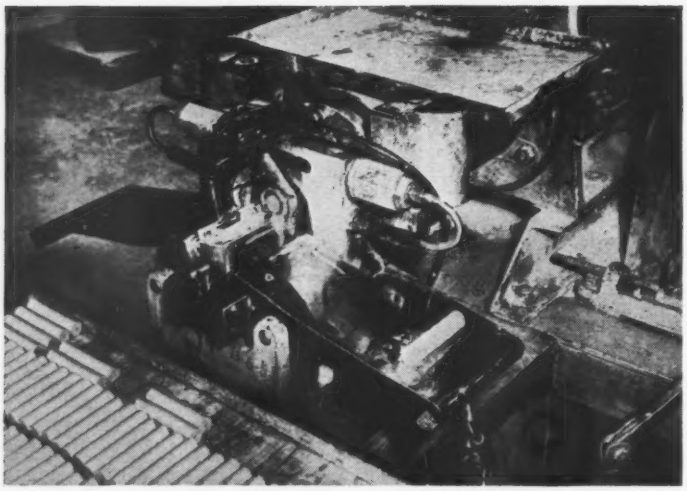


Fig. 11. The extrusion process, showing extruded pieces which have been parted off

triangular, or regular section, solid or tubular, and can if necessary even be produced with multi-hole bores. If the quantity is great, it is usual to incorporate the automatic cut-off device depending on the length of the blank which is required.

At this stage, the material is still of the Plasticine texture and it is necessary for it to be put through the drying process before any further machining can be carried out. This drying is usually done at a temperature of approximately 200°C and takes up to 3 - 4 hours.

After this operation, conventional machining may be carried out, depending on shape required. The material is of a chalky consistency and may be cut by abrasive wheels, drilled, tapped, counter-bored ; external form may either be turned to shape using profile turning attachment or may be ground, the latter proving to be a better process and has resulted in an extensive development of crushed form grinding machines (Figs. 12 and 13) employing multi-indexing heads. Due to the abrasive nature of the material, tungsten carbide is used for all drilling, boring and turning.

If pressing is the selected process, the extent of tooling is dictated by the size of the order involved and it may be found economic to press only a plain disc or cylinder by conventional tools and from that stage do individual machining operations as

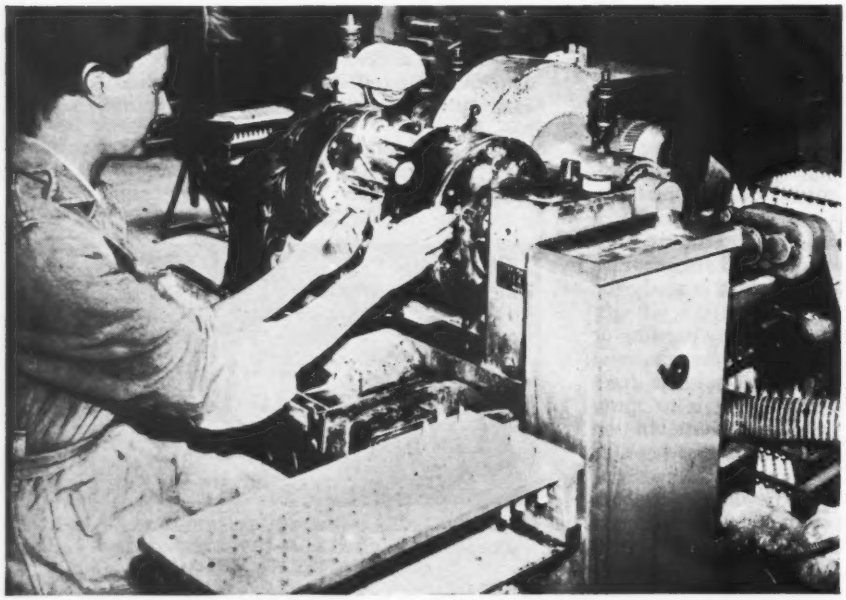


Fig. 12. Crushed form grinding machine with multi-indexing head

previously mentioned. If, however, the quantity is large and the order justifies the expense of tooling, then the answer is to press the article as near complete as possible in one operation. The type of press usually employed is of the tableting type where the die is open both ends and there is an equivalent of a top and bottom punch. Ideally, pressure should be applied in all directions to give an equal density throughout the pressing. As this is very impractical, usually pressure is applied at the top and bottom only.

The bottom punch and ejector never clear the die; powder is fed into the die cavity with the bottom punch at the appropriate position to give correct depth of fill. The top punch descends and on entering the die, commences to compact the powder at the top. After the pressure, top and bottom, has been equalised, the top punch comes away and the bottom punch rises, acting as an ejector, and the pressing is pushed clear of the die.

On high speed machines it is usual to employ hopper feed for material with an oscillating chute to fill the die between pressing and the time cycle is in the order of 3 - 4 seconds each.

Multi-impression tools are standard practice if the quantity required justifies the expense of tooling. Once again, due to the abrasive nature of the powder, tungsten carbide or fired ceramics are the only satisfactory way of obtaining a good tool life.

There is another method of pressing which can be employed if the shape required needs an accurate bore, but the external form is such that it cannot be ejected from a conventional die. This is known as the isostatic pressing, which uses the same type of free-flowing powder but the powder is fed into a rubber bag. A core pin equivalent to the bore dimensions is placed in the open end of the rubber bag and hydraulic pressure applied to the outside of the bag which results in compacting the powder on to the core pin. After releasing the pressure, the core pin is removed from the pressed blank and the blank is then machined by turning or grinding to complete the external form.

In either method of pressing the normal pressure required is in the order of 1 ton/sq. in. in all directions.

If the shape required is so complex that it is impossible to make by pressing or extruding and machining from the solid is too costly, casting may be employed. This involves the manufacture of a pattern of the finished article enlarged by the shrinkage and the manufacture of a number of split plaster moulds from the pattern. The slip is poured into the cavity, moisture is absorbed into the plaster mould and after a predetermined time, the mould is separated and the article removed. The moulds can be dried out and used a number of times. The resultant casting is very pliable and will not permit a lot of handling but is capable of being fettled and cleaned up.

After the material has been finally machined by whatever process has been selected, it is furnaced to cause sintering. This may be done in either a stationary type or a continuous tunnel type furnace, the temperature being approximately 1600°. The

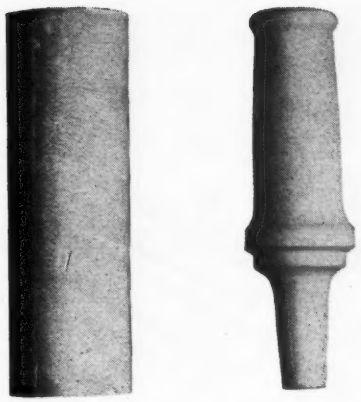


Fig. 13. An example of a blank before and after machining (see Fig. 12)

method of firing could be oil or gas and the cycle time would purely depend on the volume of material being put through, which requires heating, but is normally in the order of 40 hours continuous operation. On large scale production a tunnel type furnace could be up to 150 ft. in length.

During the sintering process there is a contraction of between 15% and 20% in all directions; this has been referred to earlier but it obviously means that the machining prior to firing must take account of this shrinkage and must be very accurate. The normal limits to which one can work for "as fired" is ± .010 in. or 2%. Once the sintering has been completed the only way in which greater accuracy can be obtained is by diamond grinding. By employing diamond grinding technique, it is possible to work to limits of the order of ± .0001 in. The operation of diamond grinding is done on conventional centreless internal or external grinding machines employing either diamond impregnated bakelite wheels or steel discs diamond impregnated, the whole of the operation being done wet.

As far as surface finish is concerned, the normal "as fired" finish is matt and gives a surface finish by C.L.A. Index of approximately 30 micro inches. By rumbling the finish may be improved on exposed surfaces to approximately 15 micro inches. A diamond ground surface using a 120 - 160 grade wheel will give a finish in the order of 20 - 23 micro inches, whereas centreless grinding gives about the same finish as rumbling (15 micro inches).

By employing lapping or polishing operations, a better finish can be obtained but it is not possible to go too far because there comes a point where by continued finishing, a crystal will pull out and leave a small cavity.

The present and possible future applications of ceramics in industry are based on experience with a high alumina type of body, and are many and varied. These materials are being used in an ever-widening field, but before detailing typical applications, let me first remind you of the main characteristics of these materials which are bringing

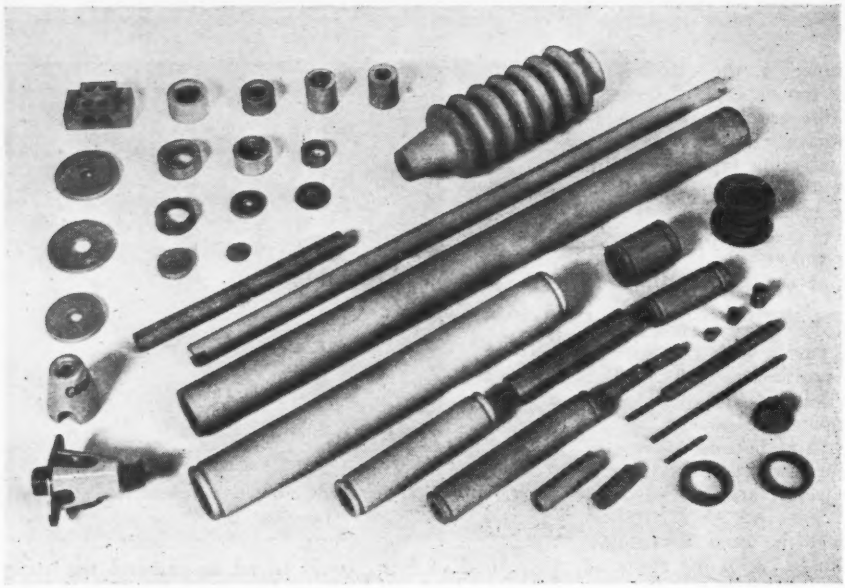


Fig. 14.
Ceramic components used in the electrical industries

this about. These may be summarised as:

good mechanical strength;
good electrical properties at high temperature;
good electrical properties at high frequencies;
good thermal conductivity combined with electrical insulating properties;
good resistance to abrasion;
good resistance to chemical attack;
accuracy of dimensions within certain size limitations.

For the purpose of illustrating the present and possible future uses to which these materials may be put, it is convenient to put them into three categories — electrical, mechanical and textile. These may also be sub-divided in certain cases.

The following typical applications within these categories will be of interest and if the main characteristics of the material as mentioned previously are borne in mind, it will be obvious why the material is attractive in these applications.

electrical and electronic (Fig. 14)

This type of ceramic is now becoming more and more widely used as a structural material in the electrical industries, due to its considerable mechanical strength rather than a purely insulating material. These purely insulating materials were often very fragile and / or temperature - conscious and usually performed only one function — that of an electrical

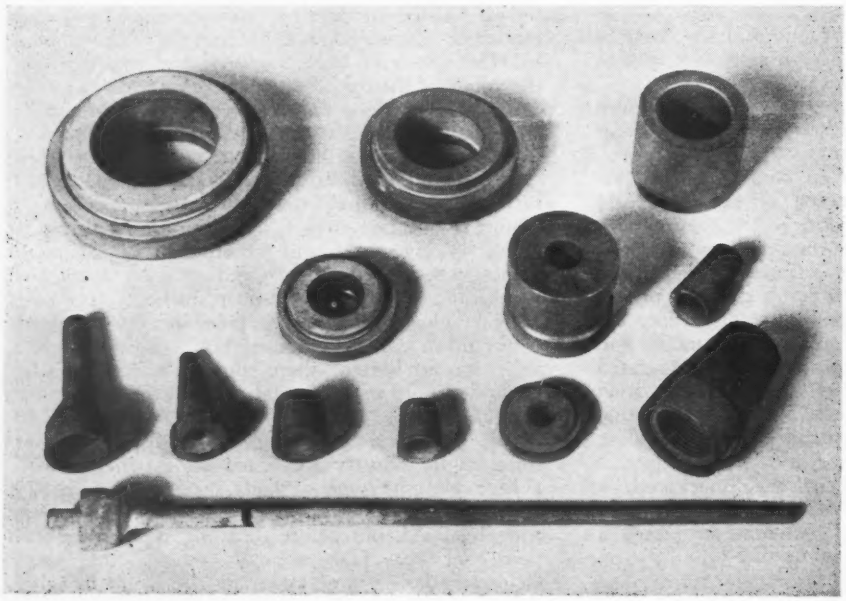


Fig. 15.
Ceramic components used in mechanical engineering

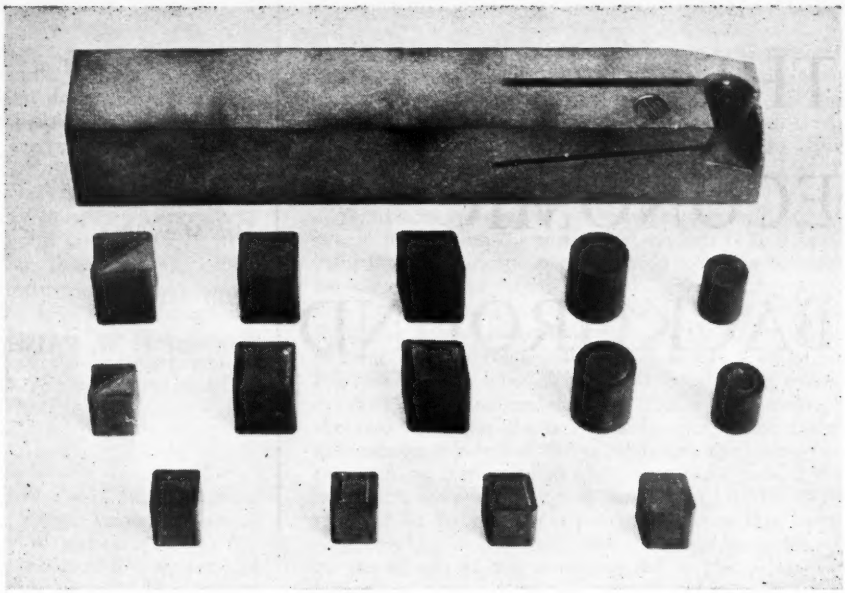


Fig. 16.
The use of ceramic for cutting tools is being widely adopted

insulator. With the advent of the higher grade ceramics, the insulator can now form part of the structure of the apparatus in many cases. Generally speaking, apparatus is getting "hotter and smaller" and a material which is a good electrical insulator, mechanically strong, can withstand heat and at the same time conduct it away, has an obvious attraction.

plain insulators

High temperature terminal blocks, bushings, switch parts, etc., for use in aircraft and guided weapon applications; voltage regulator carbon pile tubes; wire-wound resistor formers; valve spacers, supports, etc.; H.R.C. fuse bodies; high temperature relays; insulated covers for apparatus in high temperature applications; thermocouple insulators; inserts for plastic mouldings to withstand electric arcing.

There has been a large amount of research, and it is now possible to metallise ceramics suitable for soldering and brazing. As a result many new fields are open, such as:

metallised insulators (high temperature)

Valve envelopes; bodies and capsules for semiconductor devices; hermetic seals and terminations; multiple connectors; valve bases.

(*concluded on page* 547)

Fig. 17.
In the textile industry, ceramic is becoming increasingly used for thread guides and tension devices

THE ECONOMIC BACKGROUND

A Paper presented at

The Production Conference, Olympia, London,

on

14th May, 1958,

by

Professor F. W. PAISH, M.C., M.A.

I THINK I ought to warn you before I start that the subjects on which I shall speak are matters of very considerable not only political but economic controversy. Although I think I can say that the majority of my colleagues in London would be roughly in agreement with me, I feel a good many economists in other universities, perhaps particularly the older universities, would disagree rather sharply, not so much, perhaps, with the facts as with my interpretation of them.

I ought to warn you, therefore, that what I am putting before you is a point of view rather than a universally accepted doctrine.

I think that if anybody who really knew what the facts were at the end of the War could have seen how things have actually turned out today, he would have been enormously relieved, because the position at the end of the War looked, in many ways, very dark indeed. The losses of the War were not due so much to the physical damage, though that was fairly serious; probably the actual War damage would have cost at present prices something like £3,000 million to make good. But even more serious were the indirect losses, the loss of capital due to the fact that everything that was not absolutely essential for War purposes received only the absolute minimum of maintenance and replacement; that all the capital that was not needed for the War was allowed to run down, was under-maintained and under-replaced. Although a certain amount of the capital that was created for War-time purposes, particularly certain factories and engineering equipment, was capable of being turned over to peace-time use, there must have been on balance a very substantial loss of domestic capital.

Perhaps equally serious was our loss of foreign capital. Before the War we had net foreign investments abroad probably of the order of £4,000 million, which gave us an annual net income from abroad of something like £200 million a year, equivalent to something like £600 million a year at current prices.

Because of our need to finance our overseas expenditure during the War and in spite of the very generous help we had from the United States, we were obliged to sell about one-third of our best foreign investments, and we were obliged to borrow abroad, particularly on short-term, an amount greater than the remainder of our foreign investments. So for the first time, I suppose, since the reign of Charles II, this country was a net debtor country at the end of the War.

Fortunately, the yield on our foreign investments was, largely because they were equity investments, rather higher than the rate of interest we paid on our foreign debt, and we have had some foreign income since the War — some net foreign income — even after paying interest on what we owe abroad, but in money terms a good deal smaller than before the War and in real terms, of course, very much smaller.

loss in purchasing power

I should have said that in real purchasing power over imports we had lost three-quarters or four-fifths of our pre-War foreign investment income. This loss was the equivalent of perhaps something like 3% of our real national income. Perhaps almost worse from the point of view of income was the fact that the prices of imports rose much more than the prices of exports during and just after the War, so that we lost in addition an amount at present prices equivalent to about £500 or £600 million.

Of course, if you have to give more of your own produce in order to get a given amount of imports, this implies, so to speak, the cancelling out of a certain amount of your production. I would say that the loss of foreign income and the worsening terms of

trade combined involved us in the loss of something like 6% or 7% of our national income. If we add to that the running down and destruction of capital at home, I think one could say that the direct effects of the War were to reduce our national real income by something of the order of 10% at a time when our population had risen since before the War by 4%. If we had been looking only to the results of the War, we should expect this country to be very much poorer after the War than before.

In point of fact, the country today is not poorer than it was before the War: it is very substantially richer. This has been due to the fact that the rise in production since the end of the War has been at least twice as fast as the average rise in the preceding half-century.

rise in total production

Total production since the War — I am not talking about industrial production, which employed barely half the working population of the country — has risen by an average of not far short of 3% a year and production per person employed since 1948 by about 2¼%. Up to about 1948 the rise in production compared with before the War was almost entirely due to the fact that many more people were employed. We had very little unemployment as compared with a great deal before the War. Since 1948 it has been mainly, though not entirely, due to the rise in output per person employed.

The appearance of the full effects of this big rise in output was delayed because up to 1951 the terms of trade continued to move against us. Import prices continued to rise more than export prices, so that we had to give more and more of our production in order to get the same amount of imports. But since 1951 and the end of the Korean boom things have turned the other way. Import prices have fallen whilst export prices have continued to rise. Last year we had just about recovered the extra worsening of the terms of trade between 1948 and 1951.

You will see the result if you will turn to Table 3. Whereas 'Gross Domestic Product' rose slightly faster per annum in the years 1947 to 1951 than in the period 1951 to 1957, the real national income has risen nearly half as fast again in the second period as compared with the first. That is, as I said, because a large part of the gain in output in the early period was offset by the adverse swing in the terms of trade, whereas in the second period the improving terms of trade have reinforced the effects of rising output, and the result is that in the last five or six years the U.K. has been growing better off at a faster rate than probably at any time in the last 50 years, except for a few years between 1933 and 1937 when the country was recovering from the worst of the depression.

As it happens, in the '30's, largely owing to the lower import prices, the real standard of living rose faster than at any time for very many years. Certainly, the standard of living generally rises faster in a depression because we get our food and raw materials so much cheaper.

I think one can say that as far as real product is concerned the U.K. has done extraordinarly well, though not, it is true, as well as some of the Continental countries, such as Germany, which were recovering from a very much lower standard. But still very much better than we could possibly, I think, have hoped.

What are the reasons for this exceptionally rapid rise in production by previous standards? It is very difficult to say. Some people would say it is because we have had the other problem of excess demand, and that it has been mainly due to excess demand that production has risen so rapidly. That is not true of some of our foreign competitors, whose production has risen even more with very much less excess demand. I am inclined to think that a good deal of the reason is that the newer industries which came into existence only just before or during the inter-War period have continued to grow at a rapid rate. I do not think they have grown any more rapidly than they did in the inter-War period, but then they were relatively small and their effects were overshadowed by the effects of the declining old staple industries. Now these newer industries, vehicles, chemicals, large parts of engineering and so on, have become relatively so much more important that their continued rapid growth is able to lift the whole economy, whereas the older declining industries have now become so much less important that even though they are still

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Educated at Winchester and Trinity College, Cambridge, Professor Paish was employed by The Standard Bank of South Africa Limited, in London and South Africa, from 1931 - 1932. He became Lecturer in the London School of Economics in 1932, and Reader from 1938 - 1949. He was also Secretary to the London and Cambridge Economic Service from 1932 - 1941 and 1945 - 1949; and Editor from 1947 - 1949. Between 1941 and 1945, he was the Deputy Director of Programmes at the Ministry of Aircraft Production.

He is the author of a number of publications on business finance and economics.

continuing on the whole to decline, their effect has been much more than offset.

One important factor, I am sure, in the rapid growth of industries is that they have found it much easier than the older, declining industries to attract and retain at all levels energetic and intelligent management. And although it may be that the possibilities of technical innovation have been greater since the War than before, it is certainly true, I think, that on the average management has been better equipped to understand and take advantage of that technical improvement.

improvement in management

I would, therefore, say very broadly that the more rapid rise in output since the War is very largely due to better management and that in turn is very largely due to the fact that the newer, growing industries have become relatively much more important.

If, therefore, we look at real production and real national income, the results have been pretty satisfactory; even in the last two years when, for reasons I shall mention later, production has been growing more slowly, because of the continued improvement in the terms of trade, real national income has been growing at a rate not very much less than the average.

Whereas on the real national income side the results are much better than we could have hoped, there has been another side on which they have been much less satisfactory. Ever since the War, or rather from the beginning of the War, we have had prices rising continuously except for a check of barely 12 months in 1953 - 1954, and in addition we have been having balance of payments crises every two or three or four years. We have had great difficulty in paying our way internationally.

Those two things are in my view very closely linked. Some people say that the rise in prices in this country has been due to the rising costs caused by the trades unions demanding more wages. I do not agree with that. Curiously enough, my friends on the left tend to blame the trades unions for the inflation, whereas my friends on the right say no, it is not the trades unions' fault; it is due to outside causes.

My own view is that the cause of the persistent rise in wages, a rise which is faster than the rise in the quantity of things on which to spend it, has been due not so much to the fact that the trades unions have asked for higher wages as to the fact that employers have been able to pass on their higher costs in higher prices without losing business. It is not so much that the trades unions have asked for higher wages as that employers have been able to afford to pay them.

I was addressing a meeting some months ago and put that view forward, and afterwards an elderly gentleman who, I think, must have been a large employer, came up and said he did not agree with

TABLE I
SOURCES OF FUNDS INVESTED BY U.K. OUTSIDE DOLLAR AREA

	£m.						
	Average 1946–49	Average 1950–53	1954	1955	1956	1957	Average 1954–57
U.K. Balance of Payments on Current Account:							
Balance of payments on Income A/c	— 177	+ 26	+ 180	— 115	+ 240	+ 216	+ 130
Defence Aid	—	+ 57	+ 50	+ 46	+ 26	+ 21	+ 36
Balance of Payments on Current A/c	— 177	+ 83	+ 230	— 69	+ 266	+ 237	+ 166
Imports of Capital from Dollar Area:							
Grants	+ 97	+ 73	—	—	—	—	—
Increases in Sterling Balances	— 1	+ 8	+ 35	— 39	— 21	— 2	— 7
Other Capital Imports	+ 320	+ 29	+ 22	+ 19	— 60	+ 151	+ 33
Total Imports of Capital from $ Area	+ 416	+ 110	+ 57	— 20	— 81	+ 149	+ 26
Borrowings from International Funds:							
Increases in Sterling Balances	+ 144	— 16	— 35	— 7	+ 200	— 24	+ 34
Other Borrowing	— 140	— 2	— 5	+ 7	+ 4	+ 6	+ 3
Total	+ 4	— 18	— 40	—	+ 204	— 18	+ 37
Drawings on Gold and Dollar Reserve	+ 39	— 74	— 87	+ 229	— 42[1]	— 13[1]	+ 22
Total Investments Outside $ Area	+ 282	+ 101	+ 160	+ 140	+ 347	+ 355	+ 251

[1] Including £37m. in Special " Waiver " Account.

me, because he had been very reluctantly obliged to grant a wage increase in face of very strong trades union pressure. I said to him: "Did you employ the same number of people after granting the extra wages?". He said: "Yes". I said: "That proves you can afford to pay them. If you couldn't have afforded to pay them, you could not have afforded to employ as many people afterwards".

If it is true that the rise has come because employers have been able to pass on higher costs in the form of higher prices, it means that we have had a permanent condition where the demand for goods and services has been permanently above the supply at the price.

defining inflation

If I had to define inflation, I should define it not in terms of prices, which are the symptom, but as a condition in which the national money income is rising faster than the national real income; and the cure for inflation is not merely action to keep down prices. You can take action to keep down prices by subsidies and one thing and another, which can act to disguise it, but only to disguise it and not to remove it. The real thing to look at is whether incomes are rising faster than the supply of things to spend them on.

If you get a position like that — and I shall discuss the reasons for it in a moment — you get two things. First, you get an excess demand for the supply of goods and services which are available at home, tending to push up the prices. Secondly, the effect of excess demand has a direct effect on the balance of payments, since it tends to suck in extra goods from abroad to supply the deficiency and to divert production away from production for export, either the goods themselves or the resources that would have made them, to production for home demand. Excess demand will therefore tend to be reflected both in the prices at home and in the balance of payments. How far it does this depends on the type of economy. If you have an almost closed economy where imports and exports are very small in relation to the size of total production at home, the result will show itself mainly in internal prices. The United States has a very much smaller import and export trade in relation to production than we have, and there the effect of inflation shows itself mainly in internal price movements. On the other hand, if you have an extremely open economy with full trade, complete freedom of movement of labour and capital and very small transport costs between that country and others, in that case the effect of excess demand would show itself almost entirely in the balance of payments. Directly demand for goods and services began to exceed supply, people and goods would come in and prevent the prices from going up, but there would be a very heavy adverse balance of payments.

This country is a mixture of the two, and we get a mixture as a result. When we get excess demand, we both get a rise in prices and a rise in imports without a corresponding rise in exports.

May we diverge a moment to look at Tables 1 and 2 and see how urgent it is for the U.K. to have a favourable balance of payments. For a century the British Commonwealth has looked to the U.K. for the capital with which to develop itself. Today we cannot help exporting a considerable amount of capital, or if you like, having to export more than we import, unless we are prepared to impose drastic exchange controls on transfers between this country and the rest of the sterling area. Much of the export of capital is on long-term to the sterling area, and it largely takes the form of direct investment.

It has recently been suggested by a couple of articles in *The Times* that our direct foreign investment consists largely of the ploughing back of profits by British companies operating abroad which are brought in on the balance of payments on income account. If this is true, we just cannot help those capital exports. In addition, we owe a great deal of money on short-term both inside and outside the sterling area, and we cannot help the owners of those short-term debts using them to pay when they have an excess of imports over exports.

Finally, we finished up the War with gold reserves which were quite inadequate in relation to our foreign debts and in relation to the size of our trade compared with before the War. We most urgently need to extend our gold reserves to provide a greater reserve against our sterling liabilities.

We have these three factors: the need, which we cannot avoid, to provide capital, particularly to such countries as Australia and New Zealand, unless we are prepared to break up the sterling area; the need, if we are to avoid default, to allow the people to whom we owe large amounts of short-term money to spend it as they need to; and the need to build up our gold reserves. These three combined mean that we need a favourable balance of payments of something like £400 million a year.

balance of payments

If you will look at Table 1, you will see that our balance of payments position has gradually improved. During the first four years after the War, apart from American aid, we had an adverse balance of payments. We were over-importing to the extent of an average of nearly £180 millions a year; in the second four-year period there was a very small favourable balance, considerably augmented by defence aid; while in the last four years we have had a favourable balance of about £130 million on an average, still augmented — though to a lesser extent — by defence aid. But this average is still less than half the favourable balance we need if we are to make sterling secure. It has had to be supplemented, as you will see from Table 1, by aid of various sorts from the dollar area and international funds. We had to borrow £200 million from the International Monetary Fund in 1956 and about £90 million from the Export-Import Bank in 1957 to help us out. We needed it mainly because we have had to use on an average about £100 million a year to repay debts of one sort or another to non-dollar countries, leaving us

TABLE 2
U.K. CAPITAL EXPORTS TO NON-DOLLAR COUNTRIES

	£m.						
	Average 1946–49	Average 1950–53	1954	1955	1956	1957	Average 1954–57
Total U.K. Investments outside $ Area	+ 282	+ 101	+ 160	+ 140	+ 347	+ 355	+ 251
Exports of Capital to other Western Hemisphere Countries:							
Grants	+ 4	+ 3	—	—	—	—	—
Decreases in Sterling Balances	+ 21	+ 10	+ 32	— 1	— 23	+ 1	+ 2
Other U.K. Capital Exports	— 45	— 19	— 47	— 1	+ 24	+ 32	+ 2
Total	— 20	— 6	— 15	— 2	+ 1	+ 33	+ 4
Exports of Capital to O.E.E.C. Countries:							
Grants	+ 21	+ 24	—	—	—	—	—
Decreases in Sterling Balances:—							
E.P.U.	—	— 50	+ 78	— 1	— 4	— 11	+ 16
Other	+ 3	+ 30	— 19	+ 30	+ 21	— 43	— 3
Other U.K. Capital Exports	+ 37	+ 42	+ 16	+ 70	+ 72	+ 135	+ 73
Total	+ 61	+ 46	+ 75	+ 99	+ 89	+ 81	+ 86
Exports of Capital to other Non-Dollar, Non-Sterling Countries:							
Grants	+ 3	—	—	—	—	—	—
Decreases in Sterling Balances	+ 27	+ 38	— 59	+ 14	+ 114	+ 59	+ 32
Other U.K. Capital Exports	+ 22	+ 33	+ 52	— 42	— 3	— 89	— 20
Total	+ 52	+ 71	— 7	— 28	+ 111	— 30	+ 12
Total Exports of Capital to Non-Dollar, Non-Sterling Countries	+ 93	+ 111	+ 53	+ 69	+ 201	+ 84	+ 102
Exports of Capital to Sterling Area	+ 189	— 10	+ 107	+ 71	+ 146	+ 271	+ 149
Exports of Capital to Sterling Area:							
Grants	— 12	—	—	—	—	—	—
Decreases in Sterling Balances	+ 59	— 160	— 126	+ 45	+ 23	+ 157	+ 25
Other Capital Exports	+ 142	+ 150	+ 233	+ 26	+ 123	+ 114	+ 124
Total Exports of Capital to Sterling Area ...	+ 189	+ 10	+ 107	+ 71	+ 146	+ 271	+ 149

with an amount which was quite inadequate for the sterling area.

We were helped to finance the export of long-term capital to the sterling area in 1946 to 1949 by American aid and in 1950 to 1953 by the fact that the Colonies got very good prices for their raw material exports and were piling up short-term balances here. They were really lending us money. In the last period we have had to get other help, and we have got it from the Export-Import Bank and the International Monetary Fund.

I would give extremely high priority to the importance for this country of getting, year in, year out, an average favourable balance of payments, large enough to enable us to bear our responsibilities. For we are still the world's banker. We cannot help being the world's banker. Some people say we should stop being the world's banker. It is not at all easy to stop being a banker when you owe nearly £4,000 million on current account. It is very much better to try to retain the confidence of your depositors than to close your doors and try to pay them off over a period of years. If you can retain their confidence you may not have to pay anything out. If you close your doors, you certainly will. It will need a favourable balance of payments, year in, year out, of something like £400 million a year to give us the confidence of the world, so that we can continue to be the world's banker and people will not want to take their money away. This is the only safeguard — to make people want to keep their money here, not force them to keep it here because we do not allow them to take it away.

Now let us turn to examine the causes of this tendency towards excess demand, of this continual pressure upward of prices.

That question of what causes excess demand is, strictly speaking, meaningless, because all demands add up, and every type of demand contributes to the total. It is open to anyone to say there is too much demand for this or that. Excess demand means that in total you are always trying to buy, at existing prices, more than you are producing. But I think we can say this. We can say which types of use of resources have gone up most. We cannot say whether they are too high or too low in any absolute sense, but we can say which uses of our resources have expanded most rapidly in recent years. Here, I think, Table 4 helps us.

increase in personal consumption

One possible excess use of resources is excess consumption. People still say personal consumption is too high, and that is, of course, a matter of opinion. But you will see, I think, if you look at the figures, that in real terms our personal consumption has gone up very much less than in proportion to real national income. The only crisis to which excessively rapid rises in personal consumption contributed was that of 1947. Personal consumption did go up quite a bit from 1946, largely, I think, as a result of the breakdown of direct controls.

It is fairly easy to restrict consumption by price controls and what-not in war-time because it is possible to restrict the output. But when resources are released from fighting and other war-time uses, it is extremely difficult to restrict the output of everything the consumers want. You may be able to restrict the output of necessities, over which the control is fairly strict. You cannot restrict the output of luxuries, and the only effect of trying to do so is to distort production. Instead of coming out of the services and war production and going into production for investment and production for export, people went into the production of non-essentials for consumption.

With the Crippsian high budget policies and heavy taxation at a time when Government expenditure was falling, that was checked, and ever since 1947 personal consumption has been taking a falling proportion of the real national income. Between 1947 and 1952 personal consumption per head, at constant prices, hardly increased at all. Since 1952 personal consumption has increased quite substantially; in fact, it is only since then that on the average the population of Great Britain has had the first real improvement in its standard of living since before the War. Nevertheless, it has increased considerably less than in proportion to the rise in the real national income. You may, of course, say that this proportion is still too high. Here personal consumption still takes nearly two-thirds of the national income, whereas in Germany the proportion is about 60% and in Russia under 50%. But Russia, of course, has techniques for controlling demand that are not available to us here.

The second scapegoat that is often blamed is excessive Government expenditure. Now by definition all Government expenditure at all times and in all places is excessive; and it is quite true that the trouble in 1951 was very largely due to a big rise in Government expenditure. If you look down the figures in Table 4, you will see that they refer only to Government expenditure on goods and services. Transfer payments, taking money away from one lot and giving it to another lot, work out in the personal consumption figures.

Between 1948 and 1952 there was a very large rise both in Government expenditure on goods and services in real terms and in the percentage of real national income that it absorbed. But since then this has been reversed. Government expenditure on goods and services in real terms has been checked and has, if anything, turned slightly downwards. With a rapidly rising real national income the proportion going to Government expenditure has been falling pretty rapidly.

Here again, just as with personal consumption we can, if we like, say that public authorities' expenditure on goods and services is still too high. Nevertheless, it is a good deal less high in relation to our resources than it was five or six years ago.

As a result of the reduction in the proportions of the national income consumed both by persons and by the Government, the balance which is saved has risen very markedly indeed, and the really hopeful element in the present situation is the quite dramatic rise that has taken place in saving in the last seven years since 1951. You will see the figures in columns 8 - 10 of Table 4. Gross saving, at 1948, constant prices, has risen from £1,700 million in 1951 to £2,860 million in 1957, a rise of the order of 60%. Gross saving is saving plus the cost of making good wear and tear and obsolescence of fixed capital. If we deduct depreciation and take net saving, that is to say, the amount which we can use, after making good wear and tear, to expand our capital of all types, this has gone up by about 130%, or well over double, since 1951 (final column in Table 5).

rise in personal saving

It is extremely encouraging that the great bulk of this increase in our saving has taken place in what is called personal saving. Not all of it is what we usually think of as personal saving, because it includes such things as the increase in the funds of life insurance offices and the rise in pension funds, even if the premiums are paid by employers, which are attributed to the ultimate beneficiaries as saving. Funds of this type have been going up rapidly and steadily, but this steady rise does not account for the two big leaps in personal saving in 1952 and 1956.

The big rise in 1952 is frequently attributed to the fact that up to that time other forms of saving had been cancelled out by people spending their past savings made in War-time, money which they had not wanted to save but which they had to save because they could not find anything to spend it on. They had been spending these savings as supplies became available.

TABLE 3
PRODUCTION, PRICES AND INCOMES IN THE UNITED KINGDOM
(Yearly Percentage Changes)

	Production and Real Income			Money Incomes			Prices		
	Index of Industrial Production	Gross Domestic Product	Gross Real National Income	Trade Union Wage Rates	Earnings	Gross Money National Income	Ratio of Money Income to Real Income	Prices of Consumption Goods and Services	Index of Retail Prices
1947	+ 6.2	+ 0.7	+ 0.5	+ 4.4	+ 8.8	+ 7.3	+ 6.8	+ 6.9	+ 5.9
1948	+ 8.7	+ 3.2	+ 3.9	+ 4.6	+ 9.6	+ 11.4	+ 7.2	+ 7.5	+ 7.3
1949	+ 6.2	+ 3.6	+ 3.8	+ 2.8	+ 3.6	+ 6.3	+ 2.4	+ 2.0	+ 2.9
1950	+ 6.6	+ 2.8	+ 1.9	+ 1.7	+ 4.3	+ 5.7	+ 3.8	+ 4.0	+ 2.7
1951	+ 3.2	+ 3.9	+ 1.0	+ 8.7	+ 10.9	+ 10.0	+ 9.0	+ 8.4	+ 9.9
Total 1947/51	+ 34.6	+ 14.8	+ 11.2	+ 24.0	+ 43.0	+ 47.6	+ 32.7	+ 32.2	+ 31.8
1952	— 3.1	+ 0.4	+ 1.6	+ 8.4	+ 7.9	+ 8.4	+ 6.8	+ 5.4	+ 8.9
1953	+ 6.2	+ 4.0	+ 5.0	+ 4.6	+ 6.6	+ 6.8	+ 1.8	+ 2.4	+ 3.1
1954	+ 7.4	+ 4.0	+ 4.0	+ 4.4	+ 6.9	+ 6.9	+ 2.9	+ 1.8	+ 1.8
1955	+ 5.5	+ 3.6	+ 3.5	+ 6.8	+ 8.9	+ 7.0	+ 3.4	+ 3.2	+ 4.3
1956	— 0.2	+ 1.4	+ 2.6	+ 7.9	+ 7.6	+ 7.9	+ 5.0	+ 4.6	+ 5.0
Total 1952/56	+ 16.0	+ 13.9	+ 17.8	+ 36.2	+ 44.4	+ 43.2	+ 21.6	+ 18.4	+ 25.2
1957	+ 1.4	+ 1.5	+ 2.3	+ 5.1	+ 4.4	+ 5.9	+ 3.5	+ 2.5	+ 4.0

TABLE 4
USES OF REAL NATIONAL INCOME
(at 1948 Market Prices)

	Consumers' Expenditure				Public Authorities' Expenditure on Goods and Services			Saving and Depreciation			Gross National Income	
	£m.	Percentage of			£m.	Percentage of		£m.	Percentage of		£m.	Percentage of 1948
		Nat. Income	1948	1948 per head of popn.		Nat. Income	1948		Nat. Income	1948		
1938	8,564	73.3	101.1	106.2	1,750	15.0	99.3	1,373	11.7	89.8	11,687	99.2
1946	8,245	73.1	97.3	98.7	2,589	23.0	147.0	437	3.9	28.6	11,271	95.8
1947	8,519	75.2	100.5	101.0	1,773	15.7	100.6	1,032	9.1	67.5	11,324	96.3
1948	8,471	72.0	100.0	100.0	1,761	15.0	100.0	1,529	13.0	100.0	11,761	100.0
1949	8,616	70.6	101.7	101.0	1,915	15.7	108.7	1,672	13.7	109.3	12,203	103.7
1950	8,825	71.0	104.2	103.3	1,899	15.3	107.9	1,705	13.7	111.5	12,429	105.6
1951	8,780	71.1	103.6	102.4	2,048	16.3	116.2	1,710	13.6	111.9	12,538	106.5
1952	8,731	68.6	103.0	101.3	2,267	17.8	128.8	1,735	13.6	113.4	12,733	108.3
1953	9,069	67.8	107.0	105.1	2,306	17.3	131.0	1,989	14.9	130.1	13,364	113.6
1954	9,472	68.2	111.9	109.6	2,287	16.4	130.0	2,144	15.4	140.2	13,903	118.2
1955	9,778	68.0	115.6	112.9	2,255	15.7	128.0	2,351	16.3	153.8	14,384	122.2
1956	9,820	66.6	116.0	112.8	2,272	15.4	129.0	2,653	18.0	173.6	14,745	125.3
1957	10,015	66.4	118.2	114.3	2,195	14.6	124.4	2,863	19.0	187.3	15,073	128.0

TABLE 5
SOURCES OF SAVING
(£m. at 1948 prices)

	Persons and Unincorporated Businesses	Companies and Public Corporations	Tax Reserves	Public Authorities	Total Savings and Depreciation	Depreciation of Fixed Assets	Total Net Saving
1938 (Partly est.)	650	863	52	— 192	1,373	835	538
1946	358	533	— 42	— 412	437	...	...
1947	164	426	264	178	1,032	...	...
1948	30	745	182	572	1,529	889	640
1949	124	861	24	663	1,672	921	751
1950	90	894	128	593	1,705	958	747
1951	91	697	436	486	1,710	999	711
1952	547	864	— 23	347	1,735	1,023	712
1953	689	1,065	— 30	267	1,989	1,062	927
1954	565	1,210	119	250	2,144	1,107	1,037
1955	740	1,199	13	399	2,351	1,157	1,194
1956	1,010	1,170	130	343	2,653	1,179	1,474
1957	1,090	1,178	108	487	2,863	1,220	1,643

At the end of the War everybody, as you will remember, was acutely short of durable consumption goods and rushed off to replenish clothes, house furnishings, house furniture and so on as soon as they became available. I well remember about the end of the War, I was wearing my best pair of trousers when I bent down to tie up my shoe-lace, and they split clean across the seat. I had to walk down to a shop to try to get another pair holding a newspaper behind my back and trying to look as if I always carried it that way. We were all in that sort of position, and naturally many people spent their involuntary War-time savings as soon as supplies became available.

If we assume that by the end of 1951 this restocking process had come to an end it may account for the rise in personal saving in 1952, but it does not account for the further big rise of saving in 1956.

About one-third of this due to restrictions on hire-purchase, but two-thirds was due to some unknown cause. There was a further rise in 1957 in spite of some relaxation of hire-purchase restrictions. I cannot help thinking that there may be some other factors at work to supplement those I have mentioned. I rather think — and this is very much in evidence in America at the moment — that when a relaxation of inflationary pressure brings even a small drop in the demand for labour, and there is even a relatively small rise in unemployment, such as we had in 1952 and again in 1956, it makes a good many people not quite so sure of the stability of their future incomes. There is at least a chance that they may be out of work, or they won't be earning quite so much overtime, or they may be on short time. When even a small proportion of the population begins to think like that, a good many of them decide that perhaps it would be better to keep that £50 in the savings bank than to use it for a deposit on a new television set.

fall in consumer demand

There is some confirmation of this hypothesis in the fact that the fall in consumer demand in 1952, 1956 and 1957 was most marked for durables; in 1952 largely in textiles, in 1956 cars, and in 1957 largely household equipment.

However, whatever the causes, this very big rise in saving should have relieved the excessive pressure of demand, because an attempt to spend more than your income is exactly the same thing as an attempt to spend on investment, on things other than consumption, more than you save.

Normally speaking, a big rise in saving, that is, a drop in the proportion of incomes consumed, should cure an inflation. If carried too far it would cause a depression. But, in fact, after a very temporary check to inflation in 1953 - 1954, the inflation was resumed from 1954 onwards.

There is only one possible cause for this, and that is that the rise in saving was matched or more than matched by the rise in investment. If you will look at Table 6, you will see that there has indeed been in real terms a very big rise in fixed investment.

First of all, between 1952 and 1954 there was a very big rise in fixed investment in housing, largely as a result of the removal of restrictions on personal house-building and the letting loose of an enormous frustrated demand. One of the great difficulties about physical controls is that there builds up behind them a frustrated demand of quite incalculable force which is largely uncontrollable, for a time at least, by other means. Where a man has the site, the plans, the money, everything to build a house with except permission to build it, if you give him permission practically nothing on earth will stop him from building it.

We have first had this very big rise in private house-building, which has not been held down in spite of very high interest rates. On top of this, from 1954 onwards, we have had a very big rise in industrial and commercial building by companies and individuals, including the rebuilding of the City of London with very large blocks of buildings whose aesthetic merits are much debated, which has only occurred since the "go ahead" was given for commercial building. In addition, there has been a big rise in investment in industrial machinery, etc.

The combined result was that up to 1955 there was a bigger rise in fixed investment at home than in saving, at any rate if you deduct from saving the "errors and omissions". (One of the troubles with official statistics is the large item of "errors and omissions", changes in which are quite unpredictable.) I think it is best to take it off saving, because this is where the error is most likely to be.

On top of the very big rise in fixed investment, we had another element in 1955 which caused trouble — a big rise in stock-piling. Stocks normally go up — stocks of raw materials, work in progress and finished goods, including stocks in wholesale and retail hands —more or less in proportion to the rise in production, rather slower but roughly in proportion. But they do not go up steadily. What usually happens is several years of low stock-piling or actual running down of stocks, as in 1950, followed by a year of big stock-piling. We had three years of low stock-piling, 1952, 1953 and 1954, and then, in 1955, stocks were built up rapidly. In that year the combination of the high level of fixed investment at home and the high level of investment in stocks at home more than absorbed the total of saving and took us into an adverse balance of payments.

Since then, partly, I think, as a result of Government monetary policy, which has slowed down the rise in investment, but largely as a result of the marked further rise in saving, savings have caught up and gone faster ahead than fixed investment. The margin, the surplus available, which you will observe in Table 7 under "Surplus Available for Stock Accumulation and Foreign Investment", has widened very much indeed. The figures in Table 7 are all at 1948 prices and if you want to put the 1957 figure into current prices you must add about 50%.

Either we should not have been able to find a market for everything we produced, or we should have had a very much bigger favourable balance of payments in 1956 and 1957 than we had if stock

TABLE 6
GROSS DOMESTIC FIXED CAPITAL FORMATION
(£m. at 1948 prices)

	Vehicles, Ships and Aircraft			Plant and Machinery			New Dwellings			Other Building, etc.			Total		
	Private Sector	Public Sector	Total	Private Sector	Public Sector	Total	Private Sector	Public Sector	Total	Private Sector	Public Sector	Total	Private Sector	Public Sector	Total
1938	...	...	205	...	...	402	...	...	474	...	...	478	1,086	473	1,559
1946	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,058
1947	...	...	292	...	...	398	...	...	356	...	...	258	...	...	1,304
1948	211	55	266	355	135	490	45	292	337	153	182	337	764	666	1,430
1949	211	75	286	356	181	537	54	276	330	188	222	410	809	754	1,563
1950	183	70	253	393	209	602	50	273	323	218	245	463	844	797	1,641
1951	164	56	220	386	273	659	49	267	316	188	264	452	787	860	1,647
1952	161	49	210	340	284	624	77	300	377	175	285	460	753	918	1,671
1953	185	56	241	326	306	632	133	360	493	177	306	483	821	1,028	1,849
1954	205	52	257	379	320	699	177	333	510	223	309	532	984	1,014	1,998
1955	229	61	290	439	330	769	191	268	459	288	310	598	1,147	969	2,116
1956	237	84	321	467	311	778	202	246	448	328	333	661	1,234	974	2,208
1957	...	...	352	...	...	840	203	236	439	...	...	692	1,298	1,025	2,323

accumulation had not continued to rise very rapidly, partly perhaps as a result of some people's inability to sell all their production and the accumulation of stocks it involved.

But in 1957 for the first time we had a margin of saving over fixed investment at home large enough to give us the favourable balance we need — this, at 1948 prices, is about £260 million as against the £168 million we actually had in 1957 — if it had not been for the very big rise in stock-piling. This year in any case it would have been likely that we should have had a good deal less stock-piling and that we should have had a favourable balance of payments of about the order we needed. But a further development has taken place which from some points of view is fortunate and from some unfortunate — the American recession.

The fortunate result, as far as we are concerned, is that the price of imported food and raw materials has fallen substantially further. The terms of trade have improved by nearly 10% since the middle of 1957. This is equivalent to a rise in real national income of something like £300 million or £350 million at current prices. If we could sell as many exports this year as we have capacity to do, and as we should have done, I think, but for the American recession, we should have a favourable balance of payments of about £400 million without the fall in import prices. But we shall not be able to sell them. The purchasing power of our overseas customers is affected to a greater or less degree by the fall in the prices of their exports and we shall find it difficult to sell abroad as much as we sold last year, let alone more, as we should otherwise have done.

I think we should have sold more if it had not been for the American recession, if international trade had remained active, because we should have had the resources available, and because we should not have had the home demand to take up all we could make. I think that in the short run — whatever people say — the greatest enemy of increasing exports is the ability to sell them without any difficulty on your doorstep.

If you can sell all you want across the street, there is no point in spending time and energy and trouble selling on the other side of the world. When it becomes difficult to sell across the street, you take much more interest in trying to sell on the other side of the world.

It is quite true that a substantial home market provides a valuable base for anybody who is going to enter the export market. It is not true, as is sometimes stated, that a large home market is *essential* to an export market. Otherwise, I don't see how the Swiss sell their watches. I believe they consume about 3% of their production at home. But it certainly is a great help if you are established at home before you branch off abroad. But once you are established and have branched out abroad, and have something of a foreign business, I am sure some check to the home demand will cause you to take a great deal more interest in your foreign market. Where you are dependent on your foreign sales to keep you out of the red, then I think you are likely to give very much more attention to them. I have always believed that it is a very much better incentive to boards of directors to have to try to keep out of the red than to go further into the black where they are very comfortably established already.

I am quite sure, therefore, that but for the American recession things would have been very much better this year.

Now we have had two things, one on the right side and one on the wrong side. What is going to be the outcome ? I think what will probably happen is that we shall get a favourable balance of payments, probably about what we should have got without the

depression, of about £400 million. We shall probably have some drop in exports and we shall have some drop in total demand and probably some further rise here — not necessarily in unemployment but in under-used capacity. The question arises, what shall we do with it ?

We could, of course, swing right over and take steps to re-expand home demand to take up the slack. I think that would be a shortsighted policy, because we shall certainly need that export capacity and these export contacts within the next year or two unless the American recession gets worse and worse. The Americans, at any rate, do not seem to think that that is going to happen. It would be a mistake, therefore, now that we have with great difficulty squeezed out from our system enough capacity to provide the exports we need to make, to plough it back again at home and have to squeeze it out again next year.

emergency measures

It would be very much better if we took emergency measures to enable our foreign customers to buy from us, even if they cannot afford to pay cash. It is just what the grocer does in a small town which is temporarily hit by what he believes to be a temporary period of slack trade. He gives "tick" to his good customers and helps them to maintain their purchases, even if he has to finance them. I believe the first priority for us, now that we have some surplus capacity, is to try to maintain our exports, even if we have to sell them, or more of them than usual, on credit.

The second priority, I think, is to relax the restrictions on investment, and that means to allow interest rates to come down, to relax as it becomes possible the restrictions on lending, capital issues, bank advances and so on — to allow investment to recover. It is on the amount we invest now that the rise in real national income in future depends. Only after we have seen what this will do should we take up any slack that is still left by reducing taxation and allowing consumption to expand. The next Budget will probably be quite soon enough to do that.

There is one wider question, and that is this. If we are going to check inflation, we have to keep demand from re-expanding the whole way back to where it was a year or two ago. If we allow demand to re-expand all that way back, we shall get back to excess demand.

Can we maintain our rate of progress without excess demand ? It is clear that when we remove excess demand, we lose some immediate output. There is a good deal of high-cost marginal capacity which it only pays to run during periods of very high demand. A very good example is the old hand tinplate works which are now being closed down, having been kept open a good deal longer than people expected, to meet the very high demand for tinplate. A lot of old and very uneconomic ships have been kept running because of the very high demand for freight, and so on. Certainly a certain amount of output will be lost in the short run if demand is kept down to what I would regard as a normal level, a level consistent with price stability; when one discovers that one has been running a good deal of semi-obsolete high-cost equipment which it no longer pays to run.

While that is being closed or laid up or broken up, there is a temporary loss of output. But I believe, though this is highly debatable, that once the normal level has been established, once the normal margin of available capacity has been established without everything running full out all the time, it will be possible

TABLE 7
SAVING AND INVESTMENT
SOURCES AND USES OF INVESTIBLE FUNDS
(£m. at 1948 prices)

	Investible Funds				Gross Domestic Fixed Capital Formation	Surplus Available for Stock Accumulation and Foreign Investment	Use of Surplus	
	Gross Saving	Capital Grants and Transfers from Abroad	Errors and Omissions	Total Investible Funds			Physical Increase in Stocks	Net Foreign Investment
1938	1,373	...	...	1,373	1,559	— 186	...	— 186
1946	437	173	...	610	1,058	— 448	— 59	— 389
1947	1,032	172	...	1,204	1,304	— 100	+ 358	— 458
1948	1,529	234	— 19	1,744	1,430	+ 314	+ 175	+ 139
1949	1,672	186	— 50	1,808	1,563	+ 245	+ 63	+ 182
1950	1,705	159	— 22	1,842	1,641	+ 201	— 188	+ 389
1951	1,710	66	+ 20	1,796	1,647	+ 149	+ 400	— 251
1952	1,735	27	+ 86	1,848	1,671	+ 177	+ 5	+ 172
1953	1,989	21	+ 75	2,085	1,849	+ 236	+ 95	+ 141
1954	2,144	9	+ 55	2,208	1,998	+ 210	+ 35	+ 175
1955	2,351	10	— 66	2,295	2,116	+ 179	+ 230	— 51
1956	2,653	10	— 96	2,567	2,208	+ 359	+ 165	+ 194
1957	2,863	3	— 96	2,770	2,323	+ 447	+ 279	+ 168

to resume our upward movement, provided we do not overdo it as we did in 1953 - 1954, when we allowed output to expand unusually rapidly for a couple of years and got back to the old excess demand.

If we are prepared to allow demand to expand only sufficiently to take up the current growth of output leaving still a normal margin of capacity, so that we are not over-fully employed, then I think there is a very good hope that we shall be able to resume our rise.

This will mean that we shall have to get used to the idea of having more unemployed capacity, including labour, than we have had in recent years. If there is an excess demand for labour, so that there are several jobs available somewhere in the country for everybody looking for one, the chances of any particular man finding one quickly in his own line of business in his own area are very high. If the demand for labour is only equal to the supply, so that there is only one job available with everybody looking for it, then it will take a man longer to find it. It may very well be in a different part of the country or a different line of business. That will inevitably mean more transitional unemployment and the danger of little lumps of structural unemployment in areas where there is no alternative employment available.

How much employment there will be depends on how good the Government and others are in getting people and industries to move. But I believe it will be a good deal lower in the U.K. than in some others. Our industries, with minor exceptions, are well distributed, distances are short and transport facilities in normal times are good. I believe that we could manage with unemployment averaging only somewhere round about the present level, or perhaps a little higher.

But there are many problems. One is to get the trades unions used to the idea that in future wages can go up only more or less in proportion to output, though not, of course, to output in any particular firm or industry. In industries where output is increasing exceptionally rapidly wages will have to increase more slowly than output, while in industries where output is not increasing rapidly they will probably increase faster than output. Prices of products of industries where there is a rapid increase in output per head will fall, while prices where output is rising slowly will rise; but prices on the whole will remain stable.

It will take time for the trades unions to get used to the idea, and the transition period may well be a time of trial of strength.

There is always a period when there tend to be strikes at the beginning of an inflation, when the employers do not know that they can afford to pay higher wages because they will be able to pass on higher costs in higher prices. There is another period at the end of an inflation when labour does not yet know that employers cannot afford to pay higher wages because they cannot pass on higher costs in higher prices, and that they will prefer to stand the strike or, if forced to pay higher wages, will have to cut down the number of people they employ.

How serious the strikes are and how big a rise in unemployment there will be depends largely on the policies of the trades unions. Most of the trades union leaders I have met are a good deal more sensible about these things in private than they let on in public. The real difficulty lies not, I think, with either the leaders or the rank and file, but with the intermediate group who are, of course, always the most enthusiastic people, who attend branch meetings and are elected to minor offices and so forth. We may have a good deal of trouble for some months.

But I believe if the Government are courageous the period of labour trouble will not last more than a few months, and I believe we have a very good chance, provided the American recession does not get deeper and deeper, of :

1. checking the rise in prices; and
2. in the very near future resuming our rise in output at a rate of perhaps 2½% or 3% a year, or more if technical advance is so rapid that output per head rises even faster than that.

DISCUSSION

Chairman :

A. A. Jacobsen, A.M.I.Prod.E.

(Works Manager, Witney Sub-Division, Smiths Motor Accessories Ltd.)

Mr. Holman (*London*) said he gathered from what Professor Paish had said that the key to the future of the whole world economic situation was the American recession. He had, however, said very little about his thoughts on that subject. Did he think it would deepen or was it already levelling off ?

Professor Paish replied that if he knew the answer he could make a lot of money. Most American opinion seemed to be that things would begin to get very much worse but would not begin to get better until towards the end of the year. The general opinion seemed to be that things should begin to get better by the end of the year and would improve next year, though probably not very fast.

He wished he could be absolutely certain that this view was right, but he could remember what some people in the United States — not always the same people but sometimes the same people — were

saying in 1930. They were saying almost exactly the same thing as they are now. But, of course, the fact that they were not right then did not prove that they were wrong now.

On balance, he would be prepared perhaps to put 3 to 2 on the recovery from the American recession beginning by early next year. But if he were risking a lot of money on it, he would hold his horses for a little longer before making up his mind.

Mr. Hall (*Birmingham*) said he was interested in the suggestion to extend credit to American purchasers.

Professor Paish pointed out that he had not mentioned *American* purchasers: he had rather in mind such countries as Australia and New Zealand.

Mr. Hall asked whether it would not be more direct, from the point of view of profitability, to reduce prices. To extend credit facilities would mean increasing the amount of indebtedness in one's working capital. With constant prices and increased working capital, it would probably amount to the same thing as reducing prices.

Professor Paish replied that countries were unequally placed. Some had quite large sterling balances and would be able to keep going for quite a long time by using them. Others, and New Zealand immediately came to mind, were very hard up at the moment and could not do so. He thought it would be more effective to say: "You want to continue your development. If you are hard up, we will help you". He was all in favour of reducing prices, but a general cut in prices could not do very much. The people who had money would expand their consumption if prices were reduced a bit, but the people without money could not do so if prices were reduced short of 100%.

To give larger selective credits to exporters who were particularly hard up would probably do more to maintain exports than a general overall cut in prices, which was rather different because the credit need not necessarily come from the same firms. It could be put up financially from outside, whereas a cut in prices came off the actual earnings of the firms, though he had no wish to criticise people who could reduce their prices.

Perhaps even better than a reduction in prices would be a growing tendency to quote firm prices. Many exports had been lost, or so people said, because people had been told: "Well, of course, we are booked up at the moment. We are quoting 15 months' delivery, and we have no idea what it will cost you then". This was not always very encouraging, particularly when other people could quote six months' delivery and firm prices. One effect of a decline in home demand was that it enabled more and more firms, when dealing with export enquiries, to say: "Delivery in four months at these prices", so that buyers knew where they were and were more likely to send in their orders.

Mr. Van Der Hecht (*London*) said he was an engineer without special financial knowledge and he had recently returned to the U.K. after a number of years working abroad on the Continent. He was just getting the general feel of things in this country. On the Continent they had been interested for a number of years in schemes for regional association, but Britain seemed from the external viewpoint to put the brake on when any new measure was suggested. Things had now reached a point where probably within the next few months the iron and steel scheme, for example, would go forward. How did Professor Paish think British manufacturers would be affected by a working European community with only a partial British share in it? Britain had more reservations than most countries, and what about the attitude of British Commonwealth exporters when there was competition from a more or less unified Continental system?

Professor Paish said he was not an expert on this question, but knew enough about it to know that it was extremely tricky. Should there be a tight European community of six major industrial countries with a high tariff round them, excluding Britain, it would be extremely unfortunate for this country. It would be worth considerable sacrifices in every direction to be associated with the European movement.

It would be extremely difficult for the U.K. to go into a tight tariff bloc imposing tariffs on imports from the Dominions while charging no tariffs to the other members of the bloc. There were some things this country could probably afford to give up if it were not faced with that. It would probably cost less to give up Imperial preference.

He had talked in Australia last year with people who took rather a cynical view about Imperial preference. They said that except for one or two rather minor lines it was no longer of very much use to Australia. It might benefit wines, perhaps, and dried fruit, and some special items, but not the main bulk of Australian products. It was their view that Australian preference for many goods was worth a good deal more to Britain, which was reluctant to upset agricultural preferences for Dominion goods not so much because the Dominions would be hurt as because this country would be hurt if the Dominions gave up Imperial preference.

He himself felt that Britain would lose less through having to compete in Dominion markets on equal terms with European countries, than through having to compete over a high tariff wall in Europe with European countries. How they would settle their conflicts he did not know, but he felt very strongly indeed that Britain could not afford to be left out if that could possibly be avoided.

Mr. Barrett (*Chelmsford*) said that during the many years he had been in industry he had heard tremendous criticism of the poor return for personal savings. The average argument was: "I put away £50. It only earns 2½% or 3%. In purchasing power it is only worth 15s. to the £". Would it

not be right to give a higher return for the investment or guarantee the purchasing power in order to increase personal savings, and having done so to watch the effect on the general economy ?

Professor Paish said he thought the only real guarantee of purchasing power was to stop the inflation. He believed schemes for continuing inflation and allowing everyone to contract out of the unpleasant effects were self-frustrating, since an inflation only worked because it was able to swindle some people. If, in an inflation, all incomes went up as rapidly as prices, the inflation would simply burst. He had seen a series of Hungarian notes, he thought from 1946, starting with pengoes. Within a few months the noughts began to run across the top of the notes until they saved space by calling them M.Pengoes. Then the noughts began to run across the top again until they economised by calling them B.Pengoes. In the end they gave it up and started a new currency. This was what happened in an inflation that did not swindle anybody: printing more money did not give extra purchasing power because prices just rose like that.

The only real way to guarantee saving was to prevent the continued loss of purchasing power through inflation, which he would rank as number one priority, ahead of increasing production, if necessary, as compared with anything else. If it was allowed to go on it stopped the whole of the functioning of the country. Even if a gradual inflation could be managed for a short time, as more and more people became aware of it, it became more and more difficult to stop it accelerating.

He agreed that some rates of interest were inadequate to compensate for rising prices, but once stability of prices was achieved and people felt sure of stability, they would not worry nearly so much about the rate of interest they received. It was quite possible for them to get more than the 2½% offered by the Savings Bank by putting their money elsewhere. He was told the reason Savings Bank interest still stood at 2½% was that it would otherwise have to jump to 5%, because Post Office clerks could only calculate rates of 6d. or 1s. in the £.

Lord Halsbury (*Managing Director, National Research Development Corporation*) said it was symptomatic of the times that the invitations to yesterday's lecture at this Conference on productivity were posted on Thursday but were not delivered until Monday, because someone was working to rule.

They were all very grateful for the lucidity with which Professor Paish had expressed himself. It was always fascinating to listen to him, and one of his own great regrets was that he had not been one of his pupils. Whether Professor Paish also regretted it, he did not know.

He would like to ask one question arising out of the general picture that had been painted. It was rather like a portrait of Mr. Micawber. His trouble was that he had 6d. but had not got 1s. One could balance one's income to within 6d., taking one week with another, provided one had 1s. in reserve, so that expenditure of 20s. 6d. in one week could be balanced against expenditure of 19s. 6d. the next week. What Mr. Micawber needed was a reserve.

From the managing director's point of view, however prosperous the business, running it was always one damn thing after another. There was always something troublesome to cope with, but this did not show up from the shareholder's point of view, provided the business had reserves. That was why the managing director was paid a fancy salary. He was thought to be capable of coping with day-to-day troubles without the shareholders having to be bothered. If he did his work well they merely saw a steady dividend.

What was the key to a situation where there were slumps followed by booms, strikes one day and inflation the next ? Could Professor Paish elucidate a little more the difference between excessive wage demand and excessive demand for goods and services ? It would seem that to some extent they must be the same thing. The wage-earner in one trade was the consumer in the next. It seemed to Lord Halsbury that people were kidding themselves that they could beat the inflation.

If 10% of the population got an inflationary rise of 10% in wages, the price level would only rise by 1%, and those who had got the rise would apparently be 9% better off. The gain could only be transient, however, for the remaining 90% of the population would be engaged on precisely the same game. Supposing otherwise was when the element of kidding themselves came in.

Would Professor Paish agree that the two things were fundamentally the same and that the real trouble was that people had been kidding themselves since the War as to what they were capable of doing unless they were perpetually to walk along the knife edge, slipping to the left one day and to the right the next ?

Professor Paish replied that this was perfectly true. Provided all wages moved more or less together, it did not matter very much to real earnings what they did. The real enemy of one group of labour was another group of labour. One group was only better off if it got a differential rise compared with all the others. But he would put the excess demand for labour the other way round. There was excess demand for labour because there was excess demand for goods and services.

If the Government financed a big new scheme by borrowing money from the banks, this created excess demand for goods and services and made business very profitable. The business man wanted to recruit more staff and attract more labour, and this made for two things:

1. there was a tendency to pay wages above the trade union rate in one way or another, a point to which he would return later;
2. it made them not very strong at resisting a wage demand.

If he might return for a moment to Table 3, there was an interesting point on which he had meant to comment in passing — the question of wage restraint as a means of checking inflation. In the period up to 1951, under the Labour Government, there was a good deal of wage restraint that did not exist under the Conservatives. It would be seen from the fourth column in Table 3 that between 1946 and 1951 wage rates went up by 24%, whereas between 1951 and 1956 they went up by 36%, or half as much again. But the earnings of labour, the actual money they took home, went up by 43% in the first period and 44% in the second period. In other words, the fact that there was wage restraint in the first period and not in the second made practically no difference to the rate of increase in "take home" pay, because all that it meant was that the competition of employers for scarce labour forced earnings much faster above wage rates in the first period than in the second period.

Although in times of acute emergency for a short period wage restraint, like other physical controls, might be useful as an urgent measure while other measures had time to take effect, as a permanent cure it was quite illusory. There were a good many physical controls and other things which could, in an extreme emergency, be useful while more permanent but slower cures had time to come into effect. It would be a mistake to keep them on for more than a few months: it would do more harm than good. Any attempt to use physical controls, wage restraint and so on, as a permanent cure would break down after — probably — causing considerable complication.

The **Chairman** drew attention to the movement to reduce working hours and asked whether Professor Paish thought the country could afford this at the present time.

Professor Paish replied that he did not think there was a movement to reduce *working* hours: there was a movement to reduce *standard* hours. The demand for a reduction in hours was a demand for a larger proportion of wages in overtime.

Mr. W. F. S. Woodford (*Secretary, The Institution of Production Engineers*) asked Professor Paish to elucidate the problem of savings *versus* anticipating demand. If everybody saved *ad lib* it would create a problem in a few years' time, with a vast amount of spending and considerable consumption. On the other hand, one might do the opposite and buy everything on hire-purchase or extended purchase, consuming the next two or three years' consumption immediately. For example, if the ordinary man in the street wished to buy a car he could do so on hire-purchase, or he could save up for it. Suppose he started to save £1,000 and it took him four years: he might find at the end of that period that the car then cost £1,200. If he bought it on hire-purchase, what happened to production in three or four years' time when he would have been buying his car? What was the relation between advance consumption on hire-purchase and deferred consumption by saving? Was there a point in the middle where things balanced?

Professor Paish replied that there was no such thing as deferred saving. Unless savings were used currently for something, they were not made. Total income must be equal to total expenditure because expenditure was someone else's income. If money was left in the bank and that quantity of money was not spent by someone, all that happened was that one person saved more and someone else's income went down and he saved less. To save more one must invest more somewhere. What people had been doing was to try to invest more than they had been intending to save. This pushed up prices and some unfortunate people whose incomes did not go up had to cut their consumption. By having to cut their consumption because their incomes had not gone up with prices, they had to release the resources for making additional real investment.

If people tried to save without investment they would get not deferred savings, but a slump. If they tried to invest without saving they would not get anticipated consumption, but a switch from investment to consumption or, more usually, an inflationary boom.

It was no worse to borrow to buy a car than to buy a house or to buy a factory. They were all durable goods providing services. But it was important in doing so to make sure that the annual cost of servicing the debt was not out of proportion to earnings. There was no reason whatever why it should be regarded as virtuous to buy a house with money which would be paid off over 30 years, and wicked to buy furniture to put in it with borrowed money which would be paid off over two years.

This was not anticipating income but using income to save in a particular kind of way, committing oneself to a particular sort of saving. What normally happened was that if there was an increase in consumption now in the ownership of durable goods, this meant an increase in saving over the next two years while people were paying them off. This in turn was used to finance more goods.

It could be dangerous if the stage were reached where people had earmarked such a high proportion of their future incomes for these contractual payments that if their income went down a little, they could not meet them or had to cut their other consumption very violently. But this was an argument against over-borrowing and he did not believe there was any more danger in borrowing to finance durable assets than in borrowing to finance anything else.

It was always possible to have excess demand, and this might be a contributory factor towards it, but so might borrowing to build a factory or a house.

Similarly, there could be over-saving and a slump if the savings were not used, but as long as the savings were invested — and this included investment

abroad — there was no slump and people were just that much better off. If they then proceeded to spend their savings, to "dis-save", there might be trouble if everyone tried to do it. But so long as one man was saving and one dis-saving, there was no trouble. He did not anticipate any more trouble from hire-purchase than from any other form of financing durable assets.

Mr. Woodford asked what would happen in a situation such as existed in America where everyone lived on credit for everything — houses, furniture, clothing and so on. Suppose there was a collapse of the economy, a serious depression, and no one paid what they owed because they were not earning enough ?

Professor Paish replied that widespread default could cause a good deal of trouble, but even in the worst of the 1930 depression the amount of default on hire-purchase debt was remarkably small. The real danger was the tendency to intensify fluctuations in demand. With falling incomes, people still kept up their hire-purchase payments. Therefore, they had to cut down on the consumption of other things rather more drastically.

One must, however, keep a sense of proportion. Even in America the amount of outstanding hire-purchase and other consumer debt was equal in the aggregate to only about six weeks' income. It could be an aggravating factor, but as a matter of fact the amount per head of outstanding consumer debt, including (he thought) direct debt to retailers as well as hire-purchase, was equal to only about six weeks' income.

The **Chairman** said that as a layman in these matters, and a production engineer, he had often wondered why the Government did not give specially favourable tax treatment to those people who successfully engaged in export to dollar countries. He would have thought some encouragement from the Government would be essential.

Professor Paish said the British Government did not want to start an international war on subsidising exports. They had always taken a strong line on this at international conferences in the hope that if this country abstained, other countries would do the same. To subsidise exports would mean that, broadly speaking, all the industrial countries would tax themselves heavily. This might be a good thing, particularly for raw materials countries. But they could not do it without expecting other countries to do it too. The question was whether it was necessarily a good way of doing business.

Mr. Powell asked whether steps would not have to be taken to prevent free trade in view of the difference between foreign and home prices. Otherwise, it would be very difficult for this country to keep going.

Professor Paish said that on the whole prices here were moderate in comparison with those abroad. This country over-devalued in 1949, and in a great many cases British producers could be very competitive indeed in a free trade area. Until very recently both steel and coal prices were well below those on the Continent. Even though that advantage had to a considerable extent gone, he believed that the prices of the best people here were fully competitive with those abroad.

One of the effects of inflation was that the gap between the costs of the best and the less good firms was much wider here than in the United States. This was because under inflation, with excess demand, even the high-cost firms could keep going. When inflation came to an end, particularly in a free trade area, there would be a great increase in the severity of competition, and the high-cost firms would have to pull up their socks very drastically indeed if they were to keep going.

If he were among the leading firms in industry he would welcome a free trade area and would only be terrified of it if he were down towards the bottom of the list.

The **Chairman** said he had noticed in reading the synopsis of the Paper before the lecture that, according to Table 7, the physical increase in stocks had gone up to £279 million.

Professor Paish said that that would be £425 million at current prices.

The **Chairman** asked how dangerous this was. Was it really dangerous or not ?

Professor Paish replied that the figures for stocks were extremely inadequate. To some extent, the increase was probably involuntary because people had not been able to sell. It was likely that for a good many items stocks ever since the War had been below what they would have liked for effective running, particularly stocks of some types of steel. It was possible that in certain cases ample stocks were for the first time available and people were able to obtain as much as they really liked. One just did not know.

It was generally believed that aggregate stocks would not be run down this year but that there would be a much smaller rise than for some time past. This meant that all the resources that had been going into the making of stocks would have to find another use.

The **Chairman** commented that in the operation of a factory, when one wanted an easy time one tended to increase stocks. For efficiency, stocks should be low. He wondered whether the increase was symptomatic of a decrease in national efficiency.

Professor Paish said it must be remembered that stocks were at all levels. There were stocks not only of raw materials and components and work in progress, but of finished goods in the shops.

It must also be remembered that although £400 million looked large in absolute terms, it was only a 2% increase as compared with the total aggregate figure for stocks of some £8,000 million. He would not have thought the stock position dangerous. The Americans in some lines, such as cars, had stock they could not sell, blocking up the place.

But it did mean that it would not be necessary for so much in the way of resources to go into stocks for the next few years.

As to efficiency, it was true that the more efficient the business the lower the stocks it could do with, but they must be well distributed and they must be the right things. Some people had had too much of some items and not enough of others. Probably for the first time since the War people could get their stocks in the form they really liked instead of having to snap things up as they became available, whether they needed them at the moment or not.

Mr. Tribble (*London*) said he understood Professor Paish had defined inflation as national money income rising faster than national real income. If one applied that definition to the field of the Conference, which was "Production Fights Inflation", would it be true to say that the production side was concerned with the real income side of the equation but that someone other than the production engineers was concerned with the other side? Was it the task of the Government, or whose job was it?

Professor Paish replied that production could come in in two ways, either by using more resources or by getting more out of existing resources. Insofar as the production engineer could get more output without a corresponding increase in costs, he was extremely helpful in checking inflation. But where more output was obtained by calling in high-cost resources — less efficient labour or semi-obsolescent plant, and so forth — there was a more than proportional increase in costs.

The trouble in the past had been that so much of the increase in output had only been possible with the use of high-cost plant and so on which was only worth its wages under conditions of exceptional shortage. Anything the production engineer could do to bring about an increase in output with a less than proportional increase in costs would be entirely helpful.

It could not be said that an increase in output necessarily checked an inflation: an increase in output accompanied by a more than proportional increase in costs increased an inflation. An increase in output, on the other hand, accompanied by a less than proportional increase in costs, decreased an inflation. It was to the production engineers that one looked to bring about the second situation.

The **Chairman** said he felt sure Professor Paish would sympathise with him in his task of summing up the Paper and the discussion. To quote Lord Halsbury, he felt rather like a shareholder who had listened to a review of the state of the nation. Professor Paish had given a masterly summary and review of the state of the nation. He had taken them through statistics which were very difficult to understand. There would be some economists present, no doubt, but production engineers sometimes found great difficulty in interpreting the working of such statistics, and he had succeeded in making them intelligible. He had achieved an extraordinarily high standard in terms of interpretation.

Before the lecture he had asked whether there was any specific point Professor Paish thought he should cover in summing up. Professor Paish had said, as he had said during the lecture, that the general health of the economy was sound. The big problem was whether demand could be properly and sensibly checked in the right way. Success here would mean success in checking inflation.

Professor Paish's message that the economy was sound was reassuring. His view that they must deal properly with demand as a means of coping with inflation was difficult to understand, but it was one that affected them most as production engineers.

In reply to the question, what exactly did that mean to production engineers and members of the Institution as professional production engineers, he had said that many of the less efficient organisations must improve their methods. There might be temporary difficulties; there might be temporary problems. The changing of types of orders and methods to cope with the situation was a challenge, to the flexibility of the production engineer as well as to the managing director and the sales director. How they sorted it out would affect the whole economy.

This led right back to the central theme of the Conference. They were striving in this Conference and in this Exhibition to show that, regardless of the firm concerned, Great Britain was capable of finding the best methods and putting them on show and putting them across to people in other firms so that they might make use of them.

In conclusion, the Chairman said he would like to thank Professor Paish for the way he had answered the questions. He had spoken fast, clearly, lucidly and to the point throughout his discourse and in his replies. No doubt many more people would have liked to ask questions and would have received equally satisfying replies had time permitted.

On behalf of the gathering and of The Institution of Production Engineers, he thanked Professor Paish very much indeed for his excellent lecture and for handling the discussion in such a splendid manner.

The proceedings then terminated.

1960 Associate Membership Examinations Exemptions

IN the Institution's Journal for March, 1958, were published particulars of the new Associate Membership Examination which comes into force during 1960. As from that date, all exemptions afforded under the old examinations are cancelled but in order that this shall not impose undue hardship, applications for Graduate membership based on old regulations will receive sympathetic consideration until the end of 1962, if a suitable course is now being studied.

In considering exemptions, due regard has been given to the fact that facilities for the study of some subjects to the high academic level demanded by the Institution's examination are not yet universally available, although such provision is growing rapidly. Consequently many able men have been forced to follow academic studies not designed for production engineers, although they eventually enter the production engineering profession. Here, by dint of much personal application, they may eventually achieve considerable success. Having proved their worth in this way the Institution is prepared, for the time being, to accept from them certain other academic qualifications in lieu of its own examination, or parts thereof, when these men apply for corporate membership, *provided that they hold or have held adequate managerial status on the production side of industry.* A list of the qualifications at present approved is given in the Appendix hereto.

It should be borne in mind that the Institution embraces qualified production engineers engaged in all branches of manufacturing industry and is not confined to those concerned with metal working. Furthermore, these lists are not necessarily complete. If any person or body feels that some other qualification should be included, they are invited to forward particulars thereof to the Institution's Education Officer for consideration.

QUALIFICATIONS AFFORDING EXEMPTION FROM THE WHOLE OR PARTS OF THE 1960 EXAMINATIONS

In considering the award of exemptions, there are two guiding principles of policy :-

1. The academic standard, and the volume, of the material or qualification offered to obtain complete or partial exemption shall not be lower than the whole or the relevant part of the Institution's examination.
2. In applying the foregoing condition (1), the criterion shall not necessarily be " subject for subject " but " part for part ", thus :
   (a) Basic science should approximate to the requirements of Part I.
   (b) Applied science should be the equivalent of Part II, particularly bearing in mind that at least one-half of the contents of this part are concerned with the application of science to production technologies. The production technologies offered, however, need not be concerned with metal working but may refer to production in any type of industry. The requirement of production content is fundamental.
   (c) The quality and quantity of Management Studies offered should be equal to the requirements of Part III.

A. Exemption from Parts I, II and III

A1 Diploma in Technology (Eng.) in PRODUCTION ENGINEERING, gained at :

Birmingham College of Technology
Loughborough College of Technology
Northampton College of Advanced Technology (London)
Wolverhampton and Staffordshire College of Technology

A2 First degree in PRODUCTION ENGINEERING of:
Manchester University

A3 First degrees in ENGINEERING or APPLIED SCIENCE, together with the post-graduate course in PRODUCTION ENGINEERING of:
Birmingham University
London University — Imperial College

A4 Higher National Diploma in PRODUCTION ENGINEERING gained at:
Gateshead Technical College

A5 Diploma in AIRCRAFT ECONOMICS AND PRODUCTION of:
College of Aeronautics, Cranfield.

Diploma in METALLURGICAL WORKS ENGINEERING of:
Loughborough College of Technology

B. Exemptions from Parts I and II

B1 First degree in CHEMICAL ENGINEERING of the Universities of:
Birmingham ; London — Imperial College ; Manchester ; Sheffield (Fuel Technology and Chemical Engineering) ; Durham ; Leeds ; Edinburgh.

B2 First degree in METALLURGY of the Universities of:
Birmingham (Industrial Metallurgy degree only) ; London — Imperial College ; Manchester ; Durham ; Leeds (Degree "A" only) ; University College of Swansea.

B3 First degree in MINING of the Universities of:
Birmingham ; Sheffield ; Durham ; Nottingham ; Edinburgh.

B4 First degree in TEXTILES of the Universities of:
Manchester ; Belfast ; Leeds.

B5 Various first degrees, as shown, of the Universities of:
Birmingham — PETROLEUM PRODUCTION ENGINEERING
Manchester — Ordinary degree in MECHANICAL and PRODUCTION ENGINEERING, if Production Engineering subjects are taken
Sheffield — MECHANICAL ENGINEERING if Engineering Manufacture is taken — GLASS TECHNOLOGY
Durham — MECHANICAL ENGINEERING degree "b" or degree in APPLIED SCIENCE, if either is taken together with the certificate in Production Engineering
Leeds — GAS ENGINEERING
University College of Swansea — CHEMISTRY

B6 Higher National Diplomas, if PRODUCTION ENGINEERING subjects are taken, gained at:
Borough Polytechnic (London) — Mechanical/Production
Dagenham Technical College — Mechanical
Enfield Technical College — Mechanical/Production
Leicester College of Art and Technology — Mechanical

B7 Higher National Certificate in PRODUCTION ENGINEERING together with O.N.C.'s which include the subject of Production Processes, will be accepted on a subject-for-subject basis, if conditions laid down in the Institution's memorandum E.M.62/E are met.

B8 Other Higher National Certificates, together with the appropriate Ordinary National Certificates, will be accepted on a subject-for-subject basis. Higher Certificates in Mechanical Engineering which include both the subjects of Principles of Engineering Production *and* Engineering Production, to syllabuses published by The Institution of Mechanical Engineers, will exempt from Part II subjects Theory of Machine Tools and Metrology.

C. Exemption from Part I and Group A of Part II

C1 First degrees in CIVIL, or ELECTRICAL or MECHANICAL ENGINEERING of the Universities of :
Belfast ; St. Andrews ; Birmingham ; London — Imperial College ; Leeds ; Sheffield ; Durham ; Nottingham ; Southampton ; Cambridge ; Glasgow ; Edinburgh ; University College of Swansea ; London — External degrees ; Aberdeen.

C2 First degrees in CIVIL ENGINEERING of the Universities of :
Liverpool ; Bristol.

C3 First degrees in ELECTRICAL ENGINEERING of the University of :
Manchester

C4 First degrees in MECHANICAL ENGINEERING of the Universities of :
Manchester ; Liverpool.

C5 First degrees in AERONAUTICAL ENGINEERING of the Universities of :
Belfast ; London — Imperial College ; Southampton ; Cambridge ; Glasgow.

C6 First degree in METALLURGY of the Universities of :
Birmingham ; Nottingham.

C7 First degree in MINING of the Universities of :
London — Imperial College ; Cambridge ; Glasgow.

C8 First degrees in MINERAL DRESSING of the University of :
London — Imperial College

C9 First degrees in ELECTRICAL POWER and in ELECTRONIC ENGINEERING of the University of :
Liverpool

C10 Diploma in Technology (Engineering) in MECHANICAL / PRODUCTION ENGINEERING gained at :
Welsh College of Advanced Technology

C11 Diplomas in Technology, gained in Colleges listed by the National Council for Technological Awards, in :
Engineering — CIVIL, ELECTRICAL, MECHANICAL, CHEMICAL, AERONAUTICAL
Science — APPLIED PHYSICS, APPLIED CHEMISTRY, CHEMICAL TECHNOLOGY
Mathematics — APPLIED, APPLIED TO ENGINEERING

D. Exemption from Part I only

The Institution is a participant in the Engineering Institutions' Examination Committee for Part I, which Committee (not this Institution) will conduct the examinations in the subjects of :

(a) English (not after October, 1960)
(b) Mathematics
(c) Applied Mechanics
(d) Engineering Drawing
(e) Heat, Light and Sound
(f) Principles of Electricity

The Institution will, however, conduct the examinations in the additional subjects of :

(g) Production Processes
(h) Chemistry

D1 The Institution will accept for exemption against the above, the following :
Subject (a) General Certificate of Education "O" level, English Language Royal Society of Arts (Advanced) English Language and English Literature.
(b) G.C.E. "A" level — Pure Mathematics.
(c) G.C.E. "A" level — Applied Mathematics.
(d) G.C.E. "A" level — Engineering Drawing.
(e) G.C.E. "A" level — Physics.
(h) G.C.E. "A" level — Chemistry.

Candidates may, however, submit alternative qualifications of equal standard for consideration by the Institution.

E. Exemptions from Part III only

E1 Post-graduate courses in PRODUCTION ENGINEERING, successfully completed at:

Birmingham University
London University — Imperial College

E2 Full-time courses in MANAGEMENT STUDIES successfully completed at:

Loughborough College of Technology

F. Partial exemption from Part III

Partial exemption on a subject-for-subject basis is afforded where MANAGEMENT subjects are taken in the following:-

F1 Various first degrees, as shown, of the Universities of:

Cambridge — AERONAUTICAL, CIVIL, ELECTRICAL and MECHANICAL ENGINEERING
Durham — MECHANICAL ENGINEERING. CERTIFICATE IN PRODUCTION ENGINEERING
Edinburgh — ENGINEERING. CHEMICAL TECHNOLOGY
Glasgow — AERONAUTICAL, CHEMICAL, CIVIL, ELECTRICAL and MECHANICAL ENGINEERING. MINING
Leeds — MECHANICAL ENGINEERING
Manchester — MECHANICAL ENGINEERING
Nottingham — MECHANICAL ENGINEERING. METALLURGY. MINING
Sheffield — MINING

F2 Higher National Diplomas as B6 above, gained at:

Enfield Technical College
Leicester College of Art and Technology

F3 Intermediate and Final Diplomas of the British Institute of Management

F4 Endorsements of the subjects Industrial Administration A *and* B to syllabuses published by The Institution of Mechanical Engineers on a Higher National Certificate in Mechanical Engineering, will exempt from Industrial Management, and Management of Production.

APPENDIX

Qualifications accepted IN LIEU of parts of the 1960 examinations from candidates for CORPORATE MEMBERSHIP who hold or have held adequate managerial status on the production side of industry.

G. In Lieu of Parts I and II

G1 Corporate Membership, by examination of the:

Institution of Chemical Engineers
Institution of Civil Engineers
Institution of Electrical Engineers
Institution of Gas Engineers
Institution of Mechanical Engineers
Institute of Metallurgists
Institute of Physics
Institution of Structural Engineers
Plastics Institute
Royal Aeronautical Society
Royal Institute of Chemists
Textile Institute

In addition to the qualifications listed above as affording exemption or acceptable in lieu, the Education Committee have many others under active consideration. As they are resolved, they will be published in the Journal.

THE FOURTH CONFERENCE OF ENGINEERS RESPONSIBLE FOR STANDARDS

A Report of the meeting organised jointly by The Institution of Production Engineers and the British Standards Institution, and held at the Connaught Rooms, London, on 21st May, 1958.

THE CHAIRMAN, Mr. H. Stafford, of The United Steel Companies, Ltd., introducing Mr. F. J. Erroll, Parliamentary Secretary to the Board of Trade, who opened the Conference, said that Mr. Erroll's presence was an indication of the Government's interest in the Conference. Mr. Erroll himself, as an engineer in his own right, was particularly welcome and would be familiar with the problems facing the Conference.

Mr. Erroll referred to the wide scope of the Agenda, showing the range of interests among standards engineers. They were the people who put standards to the test and who made them effective in influencing the economy. The discussion on the role of the standards engineer would bring out the different ways of tackling the task of putting standards into effective use. It was important that standards engineers should meet together and should bring their influence to bear on the B.S.I. which he was sure would always welcome informed and expert opinion from the public. The Government was strongly behind the B.S.I.'s work, as was evidenced by the Government's financial contribution to B.S.I., and by the policy of Government Departments to order in accordance with British Standard specifications. The Government recognised that the preparation of national standards was only the beginning of standardisation and that the need was greater than ever before to ensure that the best and widest use was made of the standards that had been agreed. This was the more important as British Standards increasingly reflected international recommendations widely accepted in our export markets. The work to secure agreement on international standards was of major importance and a progressive attitude fully supported by management was in the U.K.'s best interests.

Mr. Erroll mentioned the increasing efforts being made to provide education on standards matters. He referred to the activities carried on by the E.P.A. to promote variety reduction and to the setting up of a new Committee of the British Productivity Council and B.S.I. to co-ordinate and encourage educational effort. The technical colleges had a large part to play and he was glad to know that they were represented at the Conference.

On the controversial subject of the inch and metric systems, Mr. Erroll said that though a single system for the whole world would simplify a lot of problems, it was clear that for a long time to come we should have to live with both systems. This situation raised complicated economic, social and technical problems and the advice of standards engineers on the technical and industrial aspects of this situation was needed and would be most valuable.

Mr. Erroll concluded by wishing the Conference success.

Increasing Interest

The Chairman thanked Mr. Erroll for his opening of the Conference. He went on to welcome the representatives of the Press who were attending the Conference for the first time. Commenting on the growth of associations of standards engineers, he reported that a standards engineers' conference had recently been held in France; that in the Netherlands, following a conference a year ago, a Commission for Standardisation in Industry had been set up; and that the United Kingdom Conferences had stimulated considerable interest in South Africa where similar meetings had been held. He suggested that consideration might be given to the position of standards engineers in the U.K. and in particular to the suggestion made by the Standards Engineers' Society of America that a British branch of the Society should be formed. The Joint I.Prod.E./B.S.I. Committee had considered this and while favouring close

collaboration with the American Society, did not agree that standards engineers in the U.K. should form a branch of it. The feeling of the Conference was in support of this view. Later in the meeting the possibility of forming a standards engineers' society in this country was suggested.

Progress Report

The Chairman then asked the Conference to consider the Progress Report. On the first part of the Report dealing with *education, training courses and publicity*, **Sir Stanley Rawson** of John Brown and Co. Ltd. reported on the work of the Joint B.P.C./B.S.I. Committee set up under his chairmanship and referred to by Mr. Erroll. The Committee had wide terms of reference and had begun its work by considering means of securing wider dissemination of information on the techniques of variety reduction and uses of standards both among those already engaged in industry and in the courses at technical colleges and universities. It was important to present the subject matter in such a way as to stimulate a better appreciation of how to apply standards in the interests of efficiency and to avoid stereotyped instruction about the general principles of standardisation which were already familiar. With this in view, it was important to have well-presented case material available.

On coding and indexing, the Chairman reported that B.S.I. was working on a sample range of British Standards to determine the basis of the headings of the coding system. He hoped that at the next Conference substantial progress might be reported. He drew attention to the availability for consultation, in B.S.I., of a card index of definitions appearing in British Standards and an index of cross references between British Standards.

In reply to **Mr. R. E. Mills,** of A. V. Roe & Co. Ltd., who asked whether B.S.I. considered *summary sheets* were valuable, **Mr. H. A. R. Binney,** Director of B.S.I., said that it was difficult for the B.S.I. to judge—it was for the users in industry to say. Judging however, from the extent to which the Germans—who seemed to have perfected the technique of summary sheets—made use of them, particularly in promoting their export trade, there seemed to be a strong case for following this example.

The ensuing discussion revealed conflicting views as to the value of summary sheets. One speaker found them too expensive, and others referred to the danger of them being used without reference to the relevant standards. A plea was made for more publications on the lines of the Building Handbook, in loose leaf form, giving summaries of related standards. **Mr. G. Weston,** Technical Director of B.S.I., pointed out that summary sheets were in fact intended to be used by those who would not have the standard itself before them. Summary sheets provided an amplification of certain information in the standard; they should not, therefore, be confused with the sheets included in the Building Handbook, which were digests of the whole content of a standard.

On international standardisation-export problems the Chairman drew particular attention to Section C which stressed the need for British exporters to provide their overseas customers with the fullest technical information about the content of the British Standards for the products which they offered.

Effectiveness of U.K. Participation in International Standards Work

Introducing this subject **Sir Stanley Rawson** underlined the need to pay greater attention than in the past to the standards requirements of overseas customers. British Standards were old and well established, but to many countries standards were comparatively new. The destruction of machinery during the War had meant that many European countries had started almost completely afresh in 1945, and had a new conception of the type of machinery they wanted. Newly-developing countries which were familiar with the latest techniques were not prepared to accept standards that were not clearly up-to-date. Neither would they accept a bald statement that a given product would perform the function it was supposed to perform; this must be demonstrated and an assurance given that the materials used had specified properties and had been tested and inspected in accordance with widely recognised methods. In many countries, standards bodies were organs of the state and standards were mandatory. If the U.K. wished to maintain its export trade it must be able to take the lead in technical discussion and satisfy customers that British Standards were completely up-to-date. It was, therefore, essential that the representatives sent to international conferences were highly competent and that they were fully briefed. He quoted examples where U.K. delegations had put forward proposals to I.S.O. Committees which were not technically defensible. Referring to the inch/metric problem, he urged the need to make clear on all appropriate occasions the fact that as tools of engineering, inch standards were as good as metric standards.

Mr. J. Winskill of Newall Group (Sales) Ltd. reinforced Sir Stanley Rawson's view that in international meetings it was not sufficient to advocate a standard because it was a British Standard and had stood the test of time; sound technical arguments must be advanced in support of our claims. One reason why this was not always done was the lack of information about the experience of users who were not always prepared to give much information. A recent circular to elicit such information had had a very disappointing response. Fuller co-operation from all concerned must be forthcoming or standards would fail to reflect the essential evidence of their effectiveness in use. To consider that a standard was determined by the biggest customer was a dangerous and erroneous attitude of mind; a wider eonsensus of opinion was required. Even where a small number of

firms dominated an industry, as in motor cars, a lot of work was sub-contracted to smaller units and it was essential for all to be aware of and agree upon the relevant standards.

Mr. Winskill strongly supported Sir Stanley Rawson in urging that delegates to international standards meetings should be the best people available; delegations should be given sufficient authority and information to be able to make quick decisions at the meetings if necessary.

Dr. Blair, of Stewarts and Lloyds, considered that taking account of the number of delegates who attended international meetings, the limited time available for meetings and the language difficulty, the criticism that progress was slow in reaching decisions was not really justified. The time taken to reach agreement often compared favourably with that taken in discussion of British Standards.

Mr. Kilby, of AC-Delco Ltd., favoured getting an agreed line with America and Canada before going to an international conference in view of the large number of firms that were linked to American companies. Commenting on this suggestion, Sir Stanley Rawson said that in the last few years there had been better co-operation in I.S.O. work from the U.S.A. and increasingly the views of inch-using countries were being co-ordinated.

Summing up, the Chairman said that the attitude of management towards international conferences on standards—and indeed on all standards matters—must change from " Whom can we spare? " to " Who is the best man to send? "

Implications of the Use in the U.K. of the Inch and Metric Systems

A note by the B.S.I. and a Paper by **Mr. H. G. Conway** were before the Conference.

Mr. Conway briefly reviewed the history of the metric system on the Continent since its introduction in France at the time of the Revolution, and referred to its permissive use in England since the middle of the nineteenth century and to the increased interest in it in recent years with the recommendation of the " Hodgson " Committee on Weights and Measures. The British Association, the Association of British Chambers of Commerce and the Federation of British Industries were all studying the problem further at the present time. Anyone who had experience of the developments in connection with the introduction of the unified screw thread into Britain would realise the difficulties of a change to the metric system.

Mr. Conway said that many firms were, of course, already using both systems and supplying export goods in millimetres, litres and grammes. It must be realized that if a change to the metric system was to be made it was not a question of converting inch dimensions in British Standards and stating them in millimetres; the change must be to nominal dimensions in the metric system. In fact, the complete range of dimensional British Standards would have to be rewritten.

The claim that the metric system was logical was, in Mr. Conway's opinion, overstated. The main advantage of the system was that the basic unit, the millimetre, was, for many purposes, more convenient than the inch, which was too large and was often divided into inconvenient fractions, e.g. $\frac{1}{64}$. He drew attention to the example given in his Paper of the economy of figures used in drawings dimensioned in millimetres as compared with those in decimalised fractions of an inch.

Mr. Conway did not underrate the difficulties of making a change in the U.K.—the problem of education, of cost, which might be as much as £200,000,000 and the disadvantage of being out of step with the U.S.A. which had little incentive to make a change. Mr. Conway felt that there was, nevertheless, an inevitability about the adoption of the metric system, though the changeover would take a very long time. He suggested that the next two generations should be taught both systems, and the third generation the metric system only. The Government would have to give a solid lead by introducing the metric system into defence specifications and by making funds available to B.S.I. to republish standards in the metric system. A Government subsidy or tax relief would be essential to induce industry to undertake the change. Stronger measures would be required than those which were being used to encourage the adoption of the unified screw thread.

To facilitate the change, Mr. Conway advocated a wider use of preferred numbers, where the inch and metric series corresponded very closely, a greater use of decimals in the inch-pound system and the suppression of such measurements as fathoms, furlongs, acres and rods, the abandonment of the Fahrenheit scale and the adoption of a decimal coinage.

He concluded with the hope that the question would be considered with more imagination than in the past and on the basis of the long-term national interest.

Mr. Tucker, of Courtaulds Ltd., underlined the importance of securing interchangeability between products made to the inch and metric systems, by the adoption of corresponding sizes. This had been done sucessfully for steel tubes. He disputed the claim that ten was the best base for a system of measurement. The base of twelve was much more satisfactory in allowing for thirds and quarters. The fact that units of the metric system were used in scientific work in the U.K. tended to suggest that only the metric system was scientific. A combination of the advantages of the decimal system with those of a system based on twelve had been advocated in a publication entitled " Douze, notre dix futur " by Paul Essig.

Other speakers also doubted the superiority of the metric system and the possibility of changing to it, so long as the U.S.A. remained on the inch/pound system. They supported, however, the establishment of corresponding values in the two systems.

Professor J. Loxham, of the College of Aeronautics, said that by 1962 agreement should have been reached to make the British and the American inch identical, and equivalent to exactly 25.4 mm. He considered that drawings dimensioned in millimetres were much easier to handle than those dimensioned in inches. Firms adopting the metric system, however, had difficulties in obtaining materials in millimetre dimensions, e.g., 10 mm. steel bar.

Mr. Gubbins, of Wolf Electric Tools Ltd., said that his firm sold a complete packaged product all over the world. The system of measurement used was not so important as to secure that the same dimensions—whether expressed in inches or millimetres—were worked to by all countries.

Mr. Orton, of Stewarts and Lloyds, supported this. He urged that the equal status of inch measurements should be upheld in I.S.O. and raised also the question of showing metric equivalents in British Standards. The bias should always be towards including them but it might not be useful in every case. **Mr. Weston** said that precise rules had not been laid down by I.S.O. on the inclusion of dimensions in both systems of measurement, but the U.K. was constantly pressing to secure this. He pointed out that the metric measures included in British Standards were approximate conversions intended as an indication of the dimensions merely to facilitate reading the standard in metric countries—they were not exact equivalents.

Mr. Canning, of the Plessey Company, said that this country was torn between the two systems both from the point of view of defence and of trade. In view of the cost of changing, we should take all possible measures to mitigate the disadvantages of the present position—by using decimals, particularly where close tolerances were being worked to, and by agreeing on corresponding values.

Another speaker held the view that price and quality were more important in the export market than whether dimensions were in inches or millimetres.

In a contribution submitted in writing, in accordance with an invitation from the Chairman, **Mr. Lambe,** of Rendel, Palmer & Tritton, expressed the view that legislation forcing manufacturers to adopt the metric system would create difficulties in the very important " inch " markets. He suggested that the chief difficulties of supply to metric users concerned the conversions of steel sections, plates and sheets, and bolts and screws, and that every endeavour should be made to direct the attention of I.S.O. to the need for the production of a system of parallel preferred sizes for steel sections, plates and sheet thicknesses for inch and metric in the same way as had been done for pipes. As regards screw threads an important point was to secure international agreement on some system of marking for the major systems of thread, so as to assist the user in avoiding confusion between the metric and inch systems.

Implementation of Standards

A note by the I.Prod.E./B.S.I. Committee was before the Conference.

Mr. Parrish, of I.C.I., introducing the subject, referred to earlier discussion on international work where the need for users to provide information on standards in use had been mentioned. The implementation of a standard when published was also a matter where strong and co-ordinated action by users would be very helpful. The manufacturers, who had their own difficulties in changing to new designs, would be helped by an indication of the business they would get.

Mr. Parrish said that sometimes great difficulties were experienced in securing supplies of goods made to new British Standards; there was a very long time-lag after a standard was published. He put forward four possible ways of improving their availability:—

(a) to ask the B.S.I. committee concerned to agree a date by which goods made to new standards should be available, the date to be published in *B.S.I. News*;

(b) to ask the manufacturers to give the date by which they would be producing goods to the new standard and for the publication of the standard to be withheld until that date;

(c) to publish tentative specifications or exploratory standards which could be modified in the light of experience;

(d) for manufacturers to be more ready to produce to the new standards as soon as they were issued.

Manufacturers could promote the sale of standard goods by charging a higher price for non-standard lines. Mr. Parrish also thought that some kind of " Buyers' Guide " was required, giving lists of manufacturers prepared to supply goods to a particular British Standard. The Paper under consideration indicated that this would cause some difficulty to B.S.I., but other means might be found.

In conclusion, Mr. Parrish advocated the wider adoption of Certification Mark Schemes which deserved strong support; these schemes were of great value to the smaller firm, which could accept " Kite marked " goods without special testing or analysis.

Mr. T. Sparling, of the Brush Electrical Engineering Company, said he thought that on the whole goods made to British Standards were reasonably widely available, and could be found if the field of suppliers was adequately explored. Suppliers were very often ready to meet demands for goods made in accordance with new standards. Certification Mark Schemes could cover any product for which there was a standard; his firm had found that use of the B.S.I. certification mark was a good selling point.

Mr. Walsh, of the British Oxygen Co., said that standards would be more readily implemented if

there were more rationalisation of the specifications dealing with the same material. He proposed a review of standards dealing with materials so that they could be integrated and simplified and those serving a purely sectional interest eliminated or combined in a more general specification; additional features for special requirements could be applied to standard materials at the customer's request. Among others he instanced the standards for light alloys including the aircraft series for these materials.

Mr. Weston said that reviews were in fact being made of the standards for steel and for non-ferrous metals with just this end in view.

Mr. Mills, of A. V. Roe & Co. Ltd., pointed out the impossibility of completely integrated standards for materials. There were great variations in the quality required. Steel required for aircraft would be of a different quality from that required for the manufacture of dustbins. An adequate range of qualities was essential.

Professor Loxham, of the College of Aeronautics, raised a problem closely related to that of implementation of standards, namely, the securing of information from users on the effectiveness of British Standards in use; better implementation would be assured if a satisfactory standard were agreed. B.S.1916, Limits and Fits, was a widely used standard, but a request from the B.S.I. committee for the views of users had met with a disappointing response. Designers, manufacturers and users should be able to arrive at satisfactory agreed tolerances, but to do so they must pool their information. B.S.1916 was under review and if essential information was forthcoming the revised version would be more stable. Co-operation of the kind he suggested could help in getting a better standard.

Mr. Williamson, of the Distillers Company, said the real question was how users could find out how soon goods produced to new standards would be available. This ought to be dealt with when the standard was still being discussed by the B.S.I. Committee.

Mr. Orton, of Stewarts and Lloyds, said that manufacturers who kept in touch with the work of preparing British Standards and put a new standard into production often found that there was no demand. There was a need for education of users as well as co-operation by manufacturers.

Mr. Waddington, of the English Electric Company, complained that often by the time a design incorporating materials to a British Standard was completed, the standards had been revised and could not be incorporated in the design.

The Role of the Standards Engineer in Industry

The Conference had before it a Paper by **Mr. R. B. Armstrong**, of Marconi's Wireless Telegraph Co. Introducing the Paper, Mr. Armstrong said that it was of course written from the point of view of his own type of firm, and that in others the emphasis might be different. Nevertheless, there were common principles to be applied and he hoped that his analysis of the functions of the standards engineer would be useful to smaller firms. The three fields of activity for any standards engineer were (a) the standards for raw materials and piece parts purchased, (b) the processes applied to these materials and parts, and (c) the marketing and possibly maintenance of the end-product. The operations he had to perform in connection with (a) could be listed as five " C's ":—Collection, Classification, Consultation, Condensation and Circulation. The collection of information about British Standards, Government-sponsored standards, or standards drawn up by Trade Associations, was an essential first step to the preparation of Company Standards and could provide a basis for them. Data on Company Standards must then be classified to suit the major design interests in each organisation. To avoid conflicting sectional views on the adoption of Company Standards, the standards engineer must ensure that they reflected the requirements of all concerned. The primary function of the Company Standard should be to condense on one sheet of paper all the information essential to the daily application of the standard. A simple and efficient system of making this information available to those who needed it must then be devised.

In design and production processes, the standards engineer in addition to his influence on the limitation of materials and components could play a large part in securing the adoption of codes of design or production practices.

In the marketing of the end-product there was a large field of activity for the standards engineer, though it was not always regarded as his province and to establish the policy in regard to the variety of products to be marketed required the full authority of management. In view of the analysis made by Professor H. W. Martin, which indicated that in many cases 80 per cent. of profits accrued from 20 per cent. of production, the importance of rationalisation in this sphere was clearly of major importance.

Mr. Kilby, of AC-Delco Ltd., congratulated Mr. Armstrong on his Paper and strongly reinforced his emphasis on the importance of reducing the variety of end products. He reported that in the field of auto accessories variety had been drastically reduced in two years, despite opposition to rationalisation from design engineers who had built up their own sets of standards. The standards engineer was often more aware of the possibilities in this regard than the central organisation.

Mr. Williamson, of the Distillers Co. Ltd., commented that the function of a standards engineer was often very much that of information officer, while **Mr. Davies** of Standard Telephones and Cables, stressed the important part a standards engineer could play in ensuring the reliability of components, a very important matter in the newer industries.

The Chairman emphasised the importance of standards engineers concentrating on the essential tasks—these were large and complicated enough. Smaller companies could probably not afford a full time standards engineer, but this did not mean that smaller companies did not have an interest in standards matters. Commenting on this, **Mr. Sanders,** Engineering Adviser to the B.S.I., suggested that in a small firm the top man should give some time to these responsibilities and the question of the variety of goods produced should be considered in connection with the firm's annual audit when prices of unremunerative items could be reviewed.

Mr. Honeywell, of Goodwin, Barsby & Co. Ltd., asked what instruction was available for a new standards engineer. **Mr. F. W. Cooper,** of the Institution of Production Engineers, said that it was hoped that instruction would be increasingly provided by technical colleges; the Chairman said that the theoretical side was comparatively easy to acquire, but to gain practical experience the best method would be to spend some months in an established standards department.

Another speaker proposed the formation of a society of standards engineers as a forum for the discussion of technical matters among standards engineers. (Further support for this suggestion has been received since the Conference).

Standardisation of Paper Sizes

The Conference had before it a note by the B.S.I.

Mr. Weston explained that this item had been specially requested and in response B.S.I. had set out the present position as regards its own usage, and the considerations which were before the B.S.I. committee in relation to international discussion. The B.S.I. decision to adopt the A4 and A5 sizes was in line with the agreement reached at the 1957 Commonwealth Standards Conference, and as far as typed documents were concerned, effected a measure of simplification in that the size of paper for international committees and for domestic use was the same.

Mr. Campbell, of British Thomson Houston Ltd., welcomed the note which was of great interest, but saw great difficulties in a change from the 10 in. by 8 in. size.

Miss Wiegand, the Secretary of the B.S.I. committee concerned with this question, explained that twenty-six countries used the "A" sizes and the possibility of a Free Trade Area in Europe had re-emphasised the need for the U.K. to consider some change in its practice. The demand for these sizes by the British engineering industry was increasing. The advantage of the range was that the same proportions were retained in all sizes. In the U.K. sizes were related to quality and there was no one stock size in all qualities. The paper industry was looking into the cutting problems—it was estimated that for duplicating paper the reduction of 3 per cent. in area was accompanied by a 6 per cent. reduction in cost. Printing machinery manufacturers were keen on the changeover since two-thirds of their total production was exported, and half of that to the Continent; and the use of the same sizes of paper in home and export markets would greatly simplify the manufacture of machinery. In view of these considerations, the B.S.I. Committee was supporting the adoption of the "A" sizes by I.S.O. though there was no suggestion that the traditional British sizes would be dropped; their usage however was likely to decline. In Sweden a complete changeover had taken fifteen years.

Summing Up

Summing up the Conference, **Mr. Mills,** of A. V. Roe & Co. Ltd., said that it had brought out the need for education and self-criticism in industry at all levels including top management. At international conferences U.K. delegates must be able to speak with one voice and the problem of conflicting loyalties between the individual's firm and the wider national interest must be resolved. For more effective work in the international field, more help was required from users and this was also required from the domestic viewpoint. Equally, however, the standards adopted must be made attractive to the user both large and small and in the U.K. there was a very large number of small users.

Mr. Mills thought that the discussion of the metric system has not been on the lines originally intended for the Conference, though many interesting points had been made. Mr. Conway had brought out the point that very strong measures would be necessary to introduce a change to the metric system. In India, it might prove that many standards would remain inch-based, though expressed in metric measures.

He considered that the question of paper sizes had been a useful item and that similar items of wide interest to industry generally should come up at future conferences.

In closing the Conference, the Chairman expressed his thanks to the staff of B.S.I. for their help in its organisation.

POLAND TODAY —

The Secretary's Report

EARLY in 1957, Mr. Woodford, the Secretary of the Institution of Production Engineers, received a visit from Mr. A. Idzkiewicz, representing the Polish Society of Mechanical Engineers, whose headquarters are in Warsaw. Mr. Idzkiewicz wished to know if the Institution would be interested in arranging for an exchange of visits between parties of members of the two Institutions.

The Polish Society of Mechanical Engineers has a total membership of about 20,000. It has various Divisions, of which Machine Tools and Production Engineering is one. It was proposed that the visit should be arranged between the Institution of Production Engineers and the Machine Tools and Production Division of S.I.M.P. (as the Polish Society is known).

Mr. Woodford informed Mr. Idzkiewicz that the Institution would welcome the suggestion in principle but there would have to be further discussion about details before a commitment could be accepted.

Mr. John Hill (right), Vice-President of the Institution, chats with Professor Tymowski, during the visit to Poland.

Shortly afterwards, Mr. Woodford received another visit, this time from Professor Tymowski, also a member of S.I.M.P., who brought the firm proposal that a party of production engineers from the United Kingdom should visit Poland in the autumn of 1957 and that a party of Polish engineers should visit this country soon afterwards. The intention was that the parties should be of equal size and that each party should be responsible for its own travel arrangements to and from the country of the visit, but the two Institutions would act as hosts and pay all expenses of the visiting parties.*

After consulting the Foreign Office, the Council of the Institution of Production Engineers accepted this invitation and plans were prepared for an exchange of visits in the autumn of 1957. It was soon realised, however, that there was not sufficient time effectively to arrange visits for these dates and so, by mutual consent, it was agreed that the visits should be postponed until the spring of 1958. It was then arranged that the Institution of Production Engineers' party would visit Poland from April 27th until May 9th and that the Polish party would make a return visit to Britain from May 11th until May 23rd (later changed to May 12th-25th).

Eighteen members of the Institution initially expressed interest in the visit and their intention to take part. In the event, however, the party finally consisted of eight members (or representatives of member firms) accompanied by the Secretary. The following left London Airport on May 9th:—

J. E. Hill (Vice-President), John Lund Ltd.
G. Ronald Pryor (Vice-President), Edward Pryor & Sons Ltd.
F. J. Everest, David Brown Industries Ltd.
W. A. Hannaby, William Asquith Ltd.
H. Stokes, Edward Pryor & Sons Ltd.
R. Unwin, Newall Group Sales Ltd.
H. Williams, Wickman Ltd.
T. N. Woof, M.C., B.S.A. Tools Ltd.
W. F. S. Woodford, Institution of Production Engineers.

* NOTE: It subsequently transpired that an approach was first made to the Institution of Mechanical Engineers, who declined.

The party flew on a B.E.A. Viking flight direct to Warsaw, leaving London Airport at 10.35 a.m. British Summer Time, and arriving in Warsaw at 3.25 Eastern European Time. The party was conducted round Poland in a Danish motor coach built on a British Leyland Royal Tiger chassis. The party travelled a total of approximately 900 miles during the twelve days in Poland. The tour began in Warsaw and went via Poznan, Breslau, Katowice, Cracow and Zakopane, and then returned via Cracow and Katowice to Warsaw. At the foot of the page is a schedule of industrial and educational establishments visited during the tour.

In addition to these industrial visits, other visits were arranged to a performance of the ballet in Warsaw and to the Chopin Institute and to the birthplace and museum of Madame Curie and to the Palace of Science and Culture, also in Warsaw. Visits were made to the opera and to the royal castle of Wawel in Cracow; to salt mines in Wieliczka; to the new planetarium in Katowice; and to the former German concentration camp at Oswiceim (Auschwitz). Three days were also spent on holiday at Zakopane, which is a resort in the Tatra Mountains on the Czechoslovak border.

General Impressions:

The following are some general impressions, grouped under various headings:—

(1) Economy

The country's chief economic problem is the reconstruction of war damage, which is very extensive. The whole of Warsaw was destroyed by the Germans; several other large towns and cities were more than 50 per cent. destroyed, and whole areas of the country —such as Lower Silesia, where endless battles raged— suffered extensive damage.

Everywhere we saw substantial building works in progress and it was evident that this immense reconstruction effort lays a heavy burden on the economy. Nevertheless, the internal economy seems to be healthy and unemployment is virtually nil. There are plenty of goods in the shops, although most of them are of a quality comparable with our war-time Utility standards. Food seemed to be plentiful and the population as a whole gave the impression of being adequately clothed and fed.

Wages are low by United Kingdom standards, but it was very difficult to make a correct assessment of relative values since the exchange rate for the pound is artificially fixed at 67 zlotys to the pound. We were told that in making a comparison it would be more accurate to assume that there were 100 zlotys to the pound. On this basis, it appeared that skilled craftsmen earn about £5 to £6 a week for a 44-hour week. An unskilled worker earns £3 10s. 0d. or £4 a week. In some branches of industry, such as mining and heavy engineering, it is possible for workers to increase their earnings by overtime and bonuses, but the average level appeared to be substantially lower than the average level in the United Kingdom.

A professional man's salary appeared to range between £500—£1,000 a year. In order to maintain a standard of living acceptable to educated people, most of the professional men have a secondary job or their wives also have professional jobs. Many engineers have part-time teaching appointments in universities and technical schools.

There appeared to be a good volume of trade between Poland and the East and there appeared also to be a strong desire to do much more business with the West, particularly the U.K., but the shortage of Western currencies is a serious obstacle.

(2) Prices

Prices vary widely in the shops, but the following are useful pointers. Clothes are mostly of a utility standard and it is possible for a workman to buy a tidy suit for about £7. On the other hand, a good pair of shoes costs £10. Cheaper shoes are available but they are rather clumsy. Food is relatively cheap and so are cigarettes. Rents are very low: the rent of a three-roomed flat with kitchen and bath and including central heating, in Warsaw is about 10s. a week. Books are very cheap. A feature of Poland is the international bookshops which are in every main

SCHEDULE OF VISITS

29.4.58	Warsaw	Technical Museum and Politechnical School	
30.4.58	Poznan	Machine Works, H. Cegielski	Machine tools, locomotives, carriages, diesel motors
„	„	Foundry, " POMET "	Iron, steel and non-ferrous castings
5.5.58	Cracow	Steelworks, " NOWA HUTA "	Iron, steel
„	„	Institute of Machine Tools and Tools	Research Institute
6.5.58	K/Bielska	Andrychow Textile Factory	Cotton (poplin), spinning, weaving and finishing
7.5.58	Swietochowice	Heavy Machine Works, " ZUT ZAGODA "	Press, motors, heavy machinery
„	Poreba K/Zawiercia	Machine tool factory Zaki Mechan. " POREBA "	Machine tools, lathes, etc.
8.5.58	Warsaw	Precision instrument and tools factory, F. W. P. Im. Gen. Swiezczewskiego	Small tools: (a) Cutting tools (b) Measurement tools

town and city. Here Polish books can be bought in a variety of foreign languages. A large book on Polish art and folk crafts, about 15 in. by 10 in. and 1½ in. thick, costs £1. Such an art book in the U.K. costs five guineas. Cameras are very cheap—about one-third of the U.K. price.

(3) Morale

In spite of the appalling conditions which must have prevailed in Poland for the last fifteen years or so, morale is astonishingly high. People everywhere were full of life and remarkably cheerful. Undoubtedly the political changes of 1956 have had a profound effect on the country. One got the impression that it is not a Communist country in the accepted sense of the term and that there is not a great deal of love lost between Poland and the East, but rather that people are mainly convinced Socialists and believe in the Socialist way of life, and that they therefore elect a Socialist form of Government. There are two other political parties which the people could vote for, that is, the Peasants Party and another party believed to be called the Democratic Party or something similar. Both these parties have seats in the House of Parliament, but undoubtedly the Socialist Government is elected by a substantial majority.

(4) Technical Progress

The visiting party saw ample evidence that Polish scientists and technologists are well informed on the most recent developments. These are by no means always put into practice in their factories, partly because they cannot afford to buy the most modern equipment, but they appear to be fully aware of their shortcomings.

We visited an electronics laboratory where modern electronic equipment has been constructed entirely from studying foreign literature. Obviously very considerable effort is put into the acquisition of foreign technical publications and translating them into Polish so that they are freely available. There was an obvious determination on the part of Polish scientists and engineers to keep fully up-to-date with world-wide developments.

Some figures about the machine tool industry, as an example, are significant. In 1950 the total production of machine tools in Poland was 12,600 tons, made up of 4,500 separate machines. In 1957 production was 39,270 tons of machine tools, made up of 22,380 separate machines. Thus in seven years the annual output of machine tools in tons has increased over 300 per cent., and in the number of pieces the increase is five-fold. This shows how in 1950 the emphasis was on heavier machine tools and how in 1957 many more lighter machine tools were being made. Some of this output is being exported, but most of it is finding its way into Polish industry, and very soon the effect of this new equipment will be shown in the increased flow of manufactured goods.

Many of the machine tools and small tools which we saw being produced were of modern design and good quality. We saw nothing which could be said to be the equal of the best work being produced by our own machine tool industry in Britain, but we saw plenty of evidence that Poland's machine tool industry is making very rapid strides and it may well be that in five years' time Poland will become a serious competitor for some of our overseas markets in machine tools.

(5) Roads, Travel and Communications

The greater part of Poland is flat and the roads are typical of Northern Europe. They are straight and narrow and the surface of the main roads is, on the

The party of Polish engineers making the reciprocal visit to the United Kingdom are here photographed during a works tour conducted by Mr. Ralph Unwin, Member, of Newall Group Sales Ltd.

whole, good. It was possible for our coach to cruise at 55-60 m.p.h. for very long distances. There is only just room for two wide vehicles to pass on most main roads, but the roads have grass verges 6 ft. to 8 ft. wide on either side which are frequently used for overtaking. These verges also provide escapes for the numerous horse-drawn vehicles in the countryside, which can thus get out of the way of fast traffic. The most typical vehicle in the Polish countryside is the long, narrow farm cart. This vehicle is immensely strongly built: it is not more than 3 ft. or 4 ft. wide but is about 15 ft. in length.

Where the roads are bad, they are very bad. From a road point of view, we were in Poland at the worst time of the year, that is, soon after the thaw when all the winter damage becomes apparent and before there has been a chance to put right the worst of it. In places frost damage was substantial and occasionally our coach was reduced to walking pace to negotiate some of the very deep pot-holes.

Traffic is extremely light. There are very few motor cars in Poland: the only people who have them are film stars, actors, authors, doctors, architects and a few of the higher paid officials and managers. There are no parking problems anywhere.

Most of the leading hotels are owned by Orbis, which is the State Travel Organisation. Those we stayed in were comfortable and well-appointed, except the one in Katowice which was very poor. The service available was very willing but often ineffectual, either because of shortage of staff, or untrained staff, or facilities not being available.

There is a good railway system in Poland and those main line trains which we saw looked clean and comfortable. Railway travel is cheaper than coach travel.

The internal telephone system in the country did not seem to be too good. One had to wait a long time to get a connection between towns and the lines were indistinct, but it was possible to make a very quick and clear connection to London.

(6) **Entertainment**

Television is just making its debut in Poland. There are only 12,000 television sets in Warsaw (population 1,000,000). The most popular forms of entertainment in Poland are the opera, the ballet and music and the cinema. Every town has its own opera house or theatre where this form of entertainment is provided and it is widely patronised. The ballet and the opera which we saw were fully attended and of very high standard.

THE STANDING COMMITTEES 1958-59

At a Meeting of Council held on 24th July, 1958, the following were elected to serve on the Institution's Standing Committees for the year 1958 - 1959:

Finance and General Purposes Committee

The Principal Officers:-

The President: The Rt. Hon. The Earl of Halsbury, F.R.I.C., F.Inst.P.

The Vice-Presidents: J. E. Hill; G. R. Pryor.

The Chairman of Council: H. W. Bowen, O.B.E.

The Vice-Chairman of Council: R. H. S. Turner.

Elected Members:-

J. Mitford Brice	E. Percy Edwards	R. E. Leakey
A. Betts Brown	H. G. Gregory	A. L. Stuchbery

The Chairmen of all Standing Committees — Editorial, Education, Hazleton Memorial Library, Membership, Papers, Research and Standards, are *ex-officio* members of the Finance and General Purposes Committee.

Education Committee

The Principal Officers

W. G. Ainslie	J. France	B. E. Stokes
J. V. Connolly	K. J. Hume	R. J. Sury
Major C. E. Darlington	A. A. Jacobsen	E. Walshaw
	Prof. J. Loxham	T. B. Worth
E. Percy Edwards	M. G. Page	

Membership Committee

The Principal Officers

A. Betts Brown	E. Percy Edwards	R. D. Owen
W. M. Buchan	T. W. Elkington	H. Spencer-Smith
J. V. Connolly	C. C. Ferguson	J. A. W. Styles
G. H. Crump	H. W. Hodson	A. C. Turner
R. Dent	K. J. Hume	B. Whittaker

Editorial Committee

The Principal Officers

J. Mitford Brice	H. P. Jost	M. J. Sargeaunt
A. A. J. Francis	J. C. Z. Martin	B. E. Stokes

Papers Committee

The Principal Officers

J. Mitford Brice	H. J. Elton	H. Peter Jost
L. Bunn	A. A. J. Francis	J. C. Z. Martin

Each Section Committee will be asked to nominate one representative to serve on this Committee. Section representatives who cannot attend Committee meetings regularly may be "Corresponding Members" and can assist in the work of the Committee by the adjudication of Papers and in other similar ways.

Hazleton Memorial Library Committee

The Principal Officers

H. L. Madeley	J. J. Peck	H. G. Shakeshaft
C. L. Aslen	R. V. Rider	J. D. Smith
L. W. Bailey	M. J. Sargeaunt	S. R. Smith
J. Isaacs	Lord Sempill	R. J. Temple

Research Committee

The Principal Officers

L. W. Bailey	Dr. D. F. Galloway	S. G. E. Nash
J. G. Collyear	R. K. Grunau	J. J. Peck
J. H. Cooper	A. G. Hayek	A. G. Pate
Dr. N. A. Dudley	P. Holmes	W. B. Pamment
B. H. Dyson	B. G. L. Jackman	P. J. Shipton
T. W. Elkington	Prof. J. Loxham	P. Spear
F. G. S. English	H. W. Mander	

Standards Committee

The Principal Officers

J. E. Baty	R. E. Mills	R. J. C. Whitaker
D. B. Ebsworth	R. V. Rider	C. M. P. Willcox
J. Harris	T. A. C. Sparling	J. H. Winskill
G. Kelly	H. Stafford	W. E. Wright

REPORT OF THE

MEETING OF COUNCIL

Thursday, 24th July, 1958

THE first Council Meeting of the 1958 - 1959 Session was held at 10 Chesterfield Street, London, W.1, on Thursday, 24th July, 1958, and was attended by 30 members. The Chairman of Council, Mr. H. W. Bowen, O.B.E., presided at the meeting, at which were present by invitation the following: Mr. B. F. Goodchild, Past Chairman of the Calcutta Section; Mr. J. W. Taylor, Honorary Secretary, Southern Region and Southampton Section; Mr. B. E. Gwynne-Clarke, Honorary Secretary, Gloucester Section; and Mr. P. M. Goodchild, Chairman, Rochester Graduate Section.

Standing Orders

The Standing Orders of Council, which are submitted to the first meeting of Council each year so that each Council shall have the opportunity of altering or rejecting any of the existing Standing Orders or of adding new ones, were adopted as printed and circulated to Council Members.

Election of Standing Committees, 1958 - 1959

The names of members elected by the Council to serve on the Standing Committees, 1958-1959, appear on page 589.

Election of Section and Region Honorary Secretaries, and Regional Honorary Treasurers

The Council confirmed the election of a number of the above officers.

Elections and Transfers

The Council approved a number of applications for membership and transfer, details of which appear on pages 593 - 594.

Finance

The Council received a report on the Institution's finances, including the Income and Expenditure Account for the year ended 30th June, 1958, and adopted the proposed budget for 1958 - 1959.

It was reported by the Finance and General Purposes Committee that their aim was to achieve a surplus of income over expenditure of 10% of the Institution's income, and considerable attention was being paid to ways and means of attaining this.

It was also noted that a certain amount of repair and renovation work was being carried out at Head Office, and a sub-committee of the Finance and General Purposes Committee had been appointed to deal with this.

Production Exhibition and Conference, 1958

The Council adopted unanimously the recommendation of the Finance and General Purposes Committee that the Institution should withdraw its official support of the Production Exhibition, having done all it usefully could in establishing this Exhibition as a biennial event.

Co-operation with the Society of Polish Mechanical Engineers

The Council received with interest a report of the successful visit to Poland made last Spring by a party of members of the Institution, together with the Secretary, at the invitation of the Society of Polish Mechanical Engineers. (This report appears on pages 586 - 589).

A reciprocal visit was paid to the U.K. by a party of Polish engineers, and most cordial relations appear to have been established by this exchange.

Revised Associate Membership Examination — Exemptions

The Chairman of the Education Committee, Mr. J. France, reported that the first list of exemptions had now been approved by the Finance and General Purposes Committee. Additional exemptions were being considered, and details would be published in the Journal from time to time. (Note: : the first list of exemptions appeared in the August Journal, and a revised list appears on pages 576 - 579 of this issue).

The Journal

It was reported by the Editorial Committee that some first-class material had again been made available for the Journal during the quarter. In particular, there had been a marked demand outside the membership for copies of the June issue.

With regard to advertising, the Committee had learned with approval that the Institution's advertising agents had appointed a special representative to look after the Journal. This representative had attended a meeting of the Editorial Committee, to discuss points and problems, and it was felt that the new appointment would be of considerable mutual benefit.

Institution Papers

The Papers Committee were pleased to report that at the suggestion of the Midlands Region the 1958 Viscount Nuffield Paper would be presented in Birmingham in March, 1959. The speaker would be Dr. N. Inglis, Metals Division Research Director, I.C.I. Ltd., who had chosen as his subject: "The Production, Fabrication, Properties and Uses of Some of the Newer Metals".

The first E. W. Hancock Paper was presented at a well-attended Session of the Production Conference on 20th May last, when Mr. Lewis Wright, Chairman of the British Productivity Council, gave an inspiring address on "Human Relations in Industry — Men, Women and Work". This meeting received widespread publicity in the national and technical press. (*See pages* 532 - 547 *of this Journal.*)

Institution Medal Awards, 1956 - 1957

The Council adopted the Papers Committee's recommendation regarding Medal Awards, as follow:

Medal for the Best Paper presented by a Member to Mr. J. A. Grainger, A.M.I.Prod.E., for his Paper on "New Techniques in Sheet Metal Forming".

Medal for the Best Paper presented by a Non-member to Mr. A. G. Thompson, for his Paper on "Measuring and Forecasting Cost Data in Highly Variable Production".

Because insufficient entries of a high enough standard had been received, the Papers Committee were unable to make a recommendation in regard to the Hutchinson Memorial Award, for the best Paper presented by a Graduate of the Institution.

Research

The following reports were made on behalf of the Research Committee:

MATERIALS HANDLING GROUP. The Group Committee met twice during the quarter, and the final arrangements for the Materials Handling Convention at Brighton, in October, were now being made. Participation in the work of the National Joint Committee on Materials Handling was continuing, together with informal talks with the Building Research Centre regarding the relationship between the production engineer and the architect.

Section Groups were becoming more active, and it had been arranged that the larger Groups would undertake specific investigations into aspects of Materials Handling.

MATERIAL UTILISATION. The Sub-Committee, through its four Panels, had completed the collection of case studies, and the drafting of the final report had been commenced.

SOURCES OF INFORMATION. One Section of the Directory remained to be completed by the Chairman of the Sub-Committee.

CONTROL OF QUALITY. The Sub-Committee had now published its Report on "Quality — Its Creation and Control", and was considering further activities.

JOINT RESEARCH COMMITTEE WITH I.C.W.A. Although the Joint Committee had not met during the quarter, preliminary work for the two Sub-Committees had been carried out independently.

Standardisation

It was reported by the Standards Committee that the Annual Conference of Standards Engineers, organised jointly with the British Standards Institution, had been an outstanding success. The Conference was opened by Mr. F. J. Erroll, Parliamentary Secretary to the Board of Trade, and was attended by more than 250 Standards Engineers. (A Report of the Conference appears on pages 580 - 585.)

The formation of the International Standards Sub-Committee had now been completed, under the Chairmanship of Mr. T. A. C. Sparling.

As a result of a survey undertaken of users and manufacturers of limit switches, a memorandum had been produced by the Standards Committee which it was hoped would lead to standardisation of these items in the machine tool field.

The Library

The Library Committee were pleased to report that statistics of enquiries and books lent continued to show an increasing use of the Library by members.

Region and Section Reports

The Council received a number of reports from Regions and Sections, extracts from which will appear in the October Journal.

Sections outside the United Kingdom

It was greatly regretted that the Vice-Chairman of Council, Mr. R. H. S. Turner, was unable to be present, owing to illness. The Secretary reported, on his behalf, that there had been several visitors to Head Office during the quarter, including Mr. E. Bishop and Mr. C. Dearman, from Australia; Mr. B. F. Goodchild, of Calcutta, who was attending the present meeting; and Mr. Roger Waindle, a Past President of the American Society of Tool Engineers and an Honorary Member of The Institution of Production Engineers. Visits were expected from Mr. T. R. Gupta, Chairman of the Calcutta Section; and Mr. S. Carroll, Vice-Chairman of the Canadian Section.

Correspondence had been received from Mr. D. E. Hamm, President of the South African Council; Mr. W. Gwinnett, President of the Australian Council; and Mr. P. Bhattacharji, retiring Chairman of the Calcutta Section.

A Past Chairman of Council, Mr. Harold Burke, would be visiting Australia later in the year, and would take the opportunity of having discussions with members there.

At the request of the Chairman, Mr. B. F. Goodchild gave a brief address to Council in which he outlined the problems which had to be faced in regard to increasing the membership in India. Any advice or suggestions which the U.K. Council felt inclined to give, said Mr. Goodchild, would be very warmly appreciated by the Section Officers in India.

The Chairman assured Mr. Goodchild that any proposals put forward by the Indian Sections would be very carefully and sympathetically considered by the Council, who were anxious to give all the assistance they could.

Honours

The Council recorded with pleasure that the following members had been honoured by Her Majesty the Queen:

O.B.E. — Mr. R. W. Mann; Mr. G. Murray.

M.B.E. — Mr. W. H. Hodgetts.

Obituary

The Council recorded with deep regret the deaths of the members whose names appear below. The Chairman referred particularly to Mr. F. T. Nurrish, M.B.E., who was so well-known to the Council and had done so much for the Institution; and to Mr. E. G. Eaton, Past Chairman of the Preston Section, whose loss would be very deeply felt in the North-West Region.

Members: E. G. Eaton; F. T. Nurrish, M.B.E.

Associate Members: E. Beresford; H. Gibbon; E. Hartley; J. J. Haslam; M. A. P. Lewis; E. E. Martin; R. Pryce-Jones.

Conference Policy

Following the routine business of Council, considerable time was devoted to a discussion on conference policy for the future. This followed a resolution adopted at the April, 1958, Meeting of Council, that the Institution should not, as a matter of habit and routine, organise national conferences on specific, recurring dates, but rather that national conferences should be organised only as and when a subject of sufficient importance to production engineers presented itself.

The Finance and General Purposes Committee felt that a much more valuable service to the membership of the Institution would be the organisation of more Regional Conferences, on the lines of the successful meetings already held, e.g., the Southampton Conference on "Problems of Aircraft Production", which had now achieved national recognition. The North Midlands Region, and the Midlands Region, had run successful conferences for several years, as had the Cornwall Section.

These conferences were usually of shorter duration than a national conference, thereby involving less leave of absence from employment, but striving to make the maximum possible use of the time available. They were intended to serve members within a particular Region, so there was thus less time lost in travelling and the level of expense was substantially lower than was involved in attendance at national conferences. In this way, it became possible for many more of the middle and junior management grades to have the benefit of attending conferences, with ultimate long-term benefit to industry.

After discussing the matter at length, the Council adopted unanimously a resolution, moved by Mr. G. R. Pryor and seconded by Mr. I. G. Hopkinson, "that this Council reaffirms the principle that any conference, of any sort whatever, must have a theme and venue, and a date, which will ensure it being entirely self-supporting".

Following this, Mr. H. G. Gregory moved that the Finance and General Purposes Committee should give consideration to holding in London every two or three years a national event of a purely social kind, to which members and friends could bring their ladies. This motion was seconded by Mr. E. P. Edwards, and carried.

Date and Place of Next Meeting

It was agreed that the next meeting of the Council would take place on Thursday, 30th Otcober, 1958, at 10 Chesterfield Street, London, W.1, at 11 a.m.

RESEARCH PUBLICATIONS

The Institution is advised by PERA that Dr. G. Schlesinger's book on "Accuracy in Machine Tools: How to Measure and Maintain It" is now out of print and cannot, therefore, be supplied. The following I.Prod.E. publication is, however, still obtainable from PERA at "Staveley Lodge" Melton Mowbray, Leicestershire.

"Practical Drilling Tests" by D. F. Galloway and I. S. Morton. Price 21s.

Owing to heavy pressure on space,

Extracts from Region and Section Reports are held over until next month.

ELECTIONS AND TRANSFERS

24th July, 1958

ADELAIDE SECTION

As Affiliated Firm
David Shearer Ltd.

BIRMINGHAM SECTION

As Member
L. E. Smith.
As Associate Member
S. E. Roberts.
As Graduates
C. A. Shakespeare; W. Chapman; E. E. Read; R. E. Shuttleworth; P. Scott; M. P. Honoré.
As Students
J. R. Winchurch; M. C. Fryer, S. Chakravarty; B. W. Walker.
Transfers
From Associate Member to Member
F. E. Wall.
From Graduates to Associate Members
A. J. Harvey; J. R. Bradshaw; W. E. Hipkiss; L. K. Lord; C. W. Cutler.
From Students to Graduates
D. E. M. Haynes; P. J. Smith; V. G. H. Tandy; B. H. Dewick.

BOMBAY SECTION

As Associate Member
M. C. Dutt.
As Graduate
K. C. Sharma.
Transfers
From Graduate to Associate Member
J. R. Rebello.
From Student to Graduate
K. V. Ramaseshan.

CALCUTTA SECTION

As Graduates
E. A. Rao; K. P. Tandon.

CANADA SECTION

As Member
T. E. H. Gwyer.
As Graduates
F. H. Gill; R. M. Rayner.
Transfers
From Graduates to Associate Members
E. W. Loveland; P. B. Clay; H. A. Turner.

CARDIFF SECTION

As Graduates
D. W. J. Williams; W. E. Jenkins.
Transfer
From Graduate to Associate Member
B. A. J. Jones; W. N. Axtell.

CORNWALL SECTION

Transfer
From Associate Member to Member
W. C. Hosken.

COVENTRY SECTION

As Members
H. Williams; H. A. M. Inshaw.
As Associate Member
S. J. Martin.
As Graduates
D. R. Price; R. A. Guice; M. J. Bowen; T. M. Jones; R. F. Clewlow.
As Students
S. J. Sherriff; A. Fisher.
Transfers
From Graduates to Associate Members
N. Cooper; D. W. Wright; J. L. Perkins; J. A. Lovell.
From Students to Graduates.
J. Griffin; R. W. Gambling; M. Spira; M. H. Denny; J. J. Hill; R. S. Riley.

DERBY SECTION

As Graduate
B. Parker.
As Student
A. R. Stevens.
Transfer
From Student to Graduate
I. A. Neish.

DONCASTER SECTION

Transfers
From Graduate to Associate Member
A. Ormondroyd.
From Student to Graduate
P. Robinson.

DUNDEE SECTION

As Students
A. Coleman; S. P. Methven; G. L. Fox; T. K. Burt.
Transfer
From Graduate to Associate Member
S. A. B. Gray.

EDINBURGH SECTION

As Member
T. Neal.

GLASGOW SECTION

As Associate Members
J. S. Sinclair; P. C. Menzies.
As Graduate
W. Hutchinson.
As Students
E. Ward; J. S. Holland; T. G. G. Hyslop.
Transfers
From Graduates to Associate Members
J. D. Duncan; R. L. N. Black; L. C. Currie; A. Gordon; H. C. Stewart.
From Student to Graduate
D. C. Loudon.

GLOUCESTER SECTION

As Associate Member
D. F. Wilce.
Transfers
From Associate Member to Member
C. W. Hotchen.
From Graduate to Associate Member
W. Edden.

IPSWICH& COLCHESTER SECTION

As Member
R. S. Warne.
As Associate Member
G. Chatterton.
As Graduate
A. F. D'Souza.

LEEDS SECTION

As Associate Members
N. Parker; G. F. G. Hinings; W. E. McConnell; A. Harwood.
As Students
G. Watson; M. Fox; F. A. Wilcock; J. Fairbrother.
Transfers
From Associate Member to Member
W. A. Clapham.
From Graduates to Associate Members
J. L. Whiteley; G. B. Croft; J. W. Sharp; T. B. Smith.
From Student to Graduate
J. M. Murray.

LEICESTER SECTION

As Member
R. A. Grierson.
As Associate Members
A. Crabtree; F. Knighton.
As Graduates
J. A. Stovin; W. C. Tang.
As Students
A. Roberts, B. K. Hollingworth.
Transfers
From Graduates to Associate Members
R. J. Cowie; J. W. Rumley, K. E. Miles.
From Student to Graduate
J. K. C. Pegg.

LINCOLN SECTION

As Member
R. Stevenson.
As Graduates
R. Highley, E. Brown, G. E. Whyte.
As Student
B. C. Wallin.

LIVERPOOL SECTION

As Associate Member
J. A. Bridge.
As Graduate
H. A. Gura.
As Students
S. J. Dilworth; M. T. Brown; D. N. Waite.
Transfers
From Graduate to Associate Member
R. Owen.
From Student to Graduate
R. G. Pitkin.

LONDON SECTION

As Associate Members
L. E. Breffit,; R. H. Norris; P. L. Rea; R. H Allen; K. E. T. Hopkins; A. S. Hayes; J. Clark; J. E. Sachs, R. O. Girdlestone; W. E. Stimson.
As Graduates
A. G. Warren; C. Westwood; A. L. Threader; G. M. Spells; C. West; R. J. Haylett; D. J. Howes; J. F. Stoddart; R. Chellappa.
As Students
V. G. Welham, R. E Finch; D. J. Briggs; J. B. Gutteridge; M. P. Green; R. J. Mead.
Transfers
From Associate Member to Member
H. R. H. Palmer.
From Graduates to Associate Members
D. H. Williams; G. E. Annan; P. H. Smith; J. Heys; F. L. Hiles; K. Blair; J. G. Dawkes; G. C. Twine.
From Students to Graduates
D. L. Allen; B. J. Taylor.

LUTON SECTION

As Associate Member
J. R. Innes.
As Graduates
R. Conquest; D. B. W. Wakeford.
As Students
B. G. Silcock; H. R. Knight; D. R. Munt.
Transfers
From Associate Member to Member
B. E. Stokes.
From Graduates to Associate Members
E. K. Ford; H. S. Woodgate; R. A. Hinkley.
From Students to Graduates
G. F. Evans; S. G. D. King; B. Johnson.

MANCHESTER SECTION

As Associate Members
S. Shaw; F. L. Travis; J. D. Sturrock; F. C. Ralph.
As Students
W. J. Makin; F. A. Wild; J. F. Pass.
Transfers
From Graduates to Associate Members
J. W. Oddey; J. A. Redston.
From Students to Graduates
F. Reddiough; S. A. Hatton; R. K. Stephenson; P. D. Pile.

MELBOURNE SECTION

As Associate Member
L. B. Worthington.
Transfers
From Graduates to Associate Members
J. W. Vosti; D. S. Worthington; R. Arthur.

NEW ZEALAND SECTION

Transfer
From Student to Graduate
P. Jeffery.

NEWCASTLE UPON TYNE SECTION

As Associate Members
A. J. Bartley; H. Stubbs.
As Graduate
R. Kirkaldy.
Transfers
From Graduates to Associate Members
D. Horsfield; A. James; A. S. Waters.

NOTTINGHAM SECTION

As Member
A. G. Weller.
Transfer
From Associate Member to Member
C. H. Hodgkins.

PETERBOROUGH SECTION

As Associate Member
J. A. W. Deboo.
As Student
D. R. Stockdale.
Transfers
From Graduate to Associate Member
R. A. Hallam.
From Student to Graduate
K. B. Karanth.

PRESTON SECTION

As Associate Member
W. A. Powell.
As Student
F. Barker.
Transfers
From Graduate to Associate Member
D. Chappell.
From Student to Graduate
F. Cunliffe.

READING SECTION

As Member
C. G. H. Govier.
As Associate Member
R. P. Geer.
As Graduate
G. A. W. Bryant.
Transfers
From Student to Graduate
C. F. Holding.

ROCHESTER SECTION

As Graduate
R. H. A. Dean.
As Student
R. A. Vane.

SHEFFIELD SECTION

As Member
H. Sadler.
Transfer
From Graduate to Associate Member
J. Rook.

SHREWSBURY SECTION

As Student
J. A. Davies.
Transfers
From Associate Member to Member
S. L. Robinson.
From Student to Graduate
W. T. Birch.

SOUTHAMPTON SECTION

As Associate Member
K. Staple.
As Graduates
R. J. Hailes; P. F. Busby; N. T. Smith.
As Students
J. E. Thompson; B. Rowland; R. J. Bryan; E. A. Horsfield.
Transfers
From Students to Graduates
T. L. Ford; G. E. Reynolds.

SOUTH AFRICA SECTION

As Member
J. Robertson.
As Associate Members
R. M. Devlin; J. C. Williams; R. Stampanoni.
As Graduate
D. J. MacDonald.
As Affiliated Firm
Anglo Transvaal Consolidated Investment Co. Ltd.

SOUTH ESSEX SECTION

As Associate Members
H. E. Hammond; J. H. Denney; F. H. Jenner; J. W. W. Day.
As Graduates
W. D. Shrubsole, G. A. Lyons, D. P. Matthams; E. J. Pound.
As Student
M. Johnson.
Transfer
From Graduate to Associate Member
E. C. Williams.

STOKE-ON-TRENT SECTION

As Associate Member
J. H. Lee.
As Graduate
N. V. B. Allman.
Transfers
From Graduate to Associate Member
R. P. Shaw.
From Students to Graduates
G. Smith; J. P. Noble.

SWANSEA SECTION

As Associate Member
H. T. Morris.
As Student
D. Axtell.
Transfer
From Graduate to Associate Member
W. D. Rance.

SYDNEY SECTION

As Associate Member
S. J. O'Keefe.
As Student
K. W. Barber.
As Affiliated Firm
Crompton Parkinson (Australia) Pty. Ltd.

TEES-SIDE SECTION

As Students
A. Matthews; G. Urwin; C. J. Horseman.
Transfers
From Associate Member to Member
N. E. Langdale.
From Student to Graduate
E. Kears.

WESTERN SECTION

As Associate Members
H. B. Dale; I. R. D. Carroll.
As Students
J. Edwards; M. J. Bolwell; J. L. Cox; D. J. Watts; D. E. Vowles; E. A. Reddicliffe.
Transfers
From Associate Member to Member
G. A. W. Morgan.
From Graduate to Associate Member
D. H. Ranford.

WOLVERHAMPTON SECTION

As Member
C. W. McDonald.
As Associate Members
J. K. Mitchell; R. C. Powell; J. R. Roberts.
As Graduates
G. L. Fletcher; I. R. Jones; T. E. Ryan; A. E. Caddick; M. R. Bellingham.
As Students
B. M. Cooper; P. J. D. Brown; K. G. Richards.
Transfers
From Graduates to Associate Members
R. H. Collins; A. L. Timings; P. C. Clough; W. G. Slater.
From Students to Graduates
J. M. T. Smallwood; M. G. Jackson; A. Griffiths; J. T. Ball; M. A. Winyard; A. Green.

WORCESTER SECTION

As Graduate
D. F. Newman.
Transfer
From Student to Graduate
M. G. Everiss.

NO SECTION

As Member
S. Szulc.
As Graduates
D. N. Trapman; F. A. Young.
Transfers
From Graduates to Associate Members
M. A. Waraich; W. Roebuck.

NEWS OF MEMBERS—

concluded from facing page

Mr. J. C. Amos, Graduate, has recently relinquished his position with Industrial Engineering Limited, Vancouver, in order to take up an appointment with the Calgary Branch of the Russell Food Equipment, Alberta, Canada.

Mr. T. E. G. Fulker, Graduate, has given up his position with Wickman Limited, in order to take up an appointment as a Specialist Sales Engineer with Messrs. Drummond-Asquith (Sales) Limited, Birmingham. Mr. Fulker is Chairman of the Coventry Graduate Section.

Mr. K. Hancock, Graduate, is now an Assistant Grade B Lecturer in Engineering at the Shrewsbury Technical College.

Mr. J. B. Watson, Graduate, has relinquished his position with the English Electric Company, Rugby, and has taken up an appointment as a Manufacturing Engineer at Canadian Westinghouse Company Limited, Hamilton, Ontario, Canada.

The Sir Walter Puckey Prize

At a recent meeting of the Council of the Institution, the establishment of a " Sir Walter Puckey Prize " was announced. This Prize is to be an annual cash award of Fifty Pounds (commencing in 1959) for the outstanding project on a Production Engineering subject in connection with the Diploma in Technology (Engineering) and has been established in recognition of the long and distinguished service rendered to the Institution, and to production engineering, by Sir Walter Puckey.

The Prize will not be limited to students taking courses in Production Engineering or Mechanical/Production Engineering, but it should be noted that the award will be made only if the projects reach a required standard in any particular year.

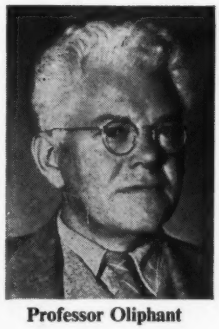
Sir Walter, who is a Past President of the Institution, is Chairman of the Board of Studies in Engineering of the National Council for Technological Awards. He is Chairman of Management Selection, Ltd., and on the Boards of The British Tabulating Machine Company, Ltd. (Hollerith); English Numbering Machines, Ltd.; Everett Edgcumbe & Company, Ltd.; and Black & Decker, Ltd.

He is also a member of Council of the British Institute of Management, and a past member of Council of the British Productivity Council.

The James N. Kirby Paper, 1958

It is announced by the Adelaide Section of the Institution, who are organising the presentation of the 1958 James N. Kirby Paper on behalf of the Australian Council, that this year's speaker will be the eminent scientist, Professor Marcus L. Oliphant, F.R.S., Director of the Research School of Physical Sciences at the Australian National University. The subject of the Paper will be " The Possibilities of Thermonuclear Power and Its Significance for Australia."

Professor Oliphant, who is internationally known for his scientific achievements, particularly in the field of nuclear physics, will be attending the Geneva Conference on Peaceful Uses of Atomic Energy this month, where the latest developments in thermonuclear power will be discussed by representatives of many countries, including Russia and the U.S.A. The knowledge gained will be of tremendous importance to Australia, and it is anticipated that some of this information will be included in the Paper, which should be an important contribution to Australian industrial progress.



Professor Oliphant

The Australian Council is proud to have the opportunity to present Papers by such eminent speakers and looks forward to further opportunities of this nature to help in improving the technological knowledge of Australia.

The meeting will take place in the " Bonython " Hall of The University of Adelaide, on 4th November next. Admission will be by ticket only, for which application should be made to the Hon. Secretary of the Adelaide Section.

NEWS OF MEMBERS

Mr. A. L. Weeks, Member, now holds the position of Director of Manufacturing with the Cockshutt Farm Equipment Limited, Brantford, Canada.

Mr. S. H. J. Freemantle, Associate Member, is now Senior Lecturer in Industrial Engineering at Kingston-upon-Thames Technical College.

Mr. E. C. Hennessy, Associate Member, has taken up an appointment with Messrs. Lightburn & Co. Ltd., Camden, South Australia.

Major E. Hughes-Jones, Associate Member, has now returned from Hong Kong and is posted to Scales Branch, R.E.M.E., Royal Dockyard, Woolwich.

Mr. S. S. Jauhari, Associate Member, until recently Assistant Director General of Ordnance Factories, has left Calcutta and taken up a new position as Superintendent, Ordnance Factory, Kanpur. This transfer has necessitated Mr. Jauhari's resignation from the Calcutta Section Committee, of which he was an extremely active member.

Mr. R. Sury, Associate Member, has relinquished his appointment as Lecturer in Work Study, Department of Production Engineering and Management, Wolverhampton and Staffs. College of Technology, to take up an appointment as Staff Tutor in the Institute of Engineering Production, Department of Engineering Production, The University of Birmingham. Mr. Sury was Hon. Secretary of the Wolverhampton Section.

Mr. L. Walmsley, Associate Member, has recently left Tubewrights Limited, Liverpool, where he was Production Engineer, and has now joined the Work Study Department of Winthrop Laboratories Limited.

(*continued on preceding page*)

Hazleton Memorial Library

ADDITIONS

Cowden, Dudley J. **"Statistical Methods in Quality Control."** *Englewood Cliffs, N. J., Prentice-Hall,* 1957. 727 *pages. Diagrams. Charts. Tables.* 74s. 6d.

The administrative organisation for quality control is not covered by this book, the emphasis of which is on the statistical bases for the techniques used and on the techniques themselves, and a knowledge of mathematics and of statistical theory is necessary for its comprehension.

Contents: Probability, statistics and quality control — Summarisation of statistical data — Elementary principles of probability — The binomial and multinomial distributions — The normal distribution — Criteria for choice of estimators of parameters — Principles of estimation — Tests of hypotheses and confidence limits: mean and fraction defective — Tests of hypotheses and confidence limits: standard deviation and chi-square — Analysis of variance — Tests of control of a variable based on amounts of variability — Tests of control based on patterns of variability — Analysis of historical data — Analysis of a process subject to sporadic changes in cause system and systematic differences among categories — Specifications parameters and statistics — Use of control charts for variables during production — Selection of statistic and computational procedures — Operating characteristics of control charts for variables—Comparison of process control plans — Systems of frequency curves for a continuous variable — Control charts for non-normal distributions — Miscellaneous control charts for variables — Analysis of number or fraction defective: large samples — Analysis of defectives: selected techniques — The Poisson distribution — Control charts for number of defects — Estimating with an equation of relationship — Sloping control lines — The economics of control charts — Single sampling plans for mean, standard deviation known — Principles of lot acceptance sampling for attributes — The hypergeometric distribution — Single sampling plans for attributes: small lots — Single sampling plans for attributes: large lots — Double sampling — Item-by-item sequential sampling — Multiple sequential sampling — Military standard 105A — Single sampling for variables σ unknown — Analysis of pattern of variability — Charts and tables.

Institution of Mechanical Engineers, London. **"Proceedings of the International Conference on Fatigue of Metals — London, September, 1956; New York, November, 1956."** *London, the Institution,* 1958. 961 *pages. Illustrated. Diagrams.* 90s.

The Conference was sponsored by The Institution of Mechanical Engineers and the American Society of Mechanical Engineers. Eighty-one Papers were presented and are here published together with discussions, communications and authors' replies. The Papers were divided into eight sessions as follows: *Session 2 and* 3 — Stress distribution. *Session* 4 — Temperature, frequency and environment. *Session* 5 — Metallurgical aspects of fatigue. *Session* 6 — Basic aspects of fatigue. *Session* 7 — Engineering and industrial significance of fatigue: general service, automobiles and specific components. *Session* 8 — Engineering and industrial significance of fatigue: airframes and engines. *Session* 9 — Engineering and industrial significance of fatigue: marine engines, railways and welding. Each section is summarised by a reporter

"The Practical Engineer Pocket Book" — with technical dictionaries in German, French and Spanish. Edited by N. P. W. Moore. 66th edition. *London, Pitman,* 1958. 744 *pages. Illustrated. Diagrams. Tables.* 12s. 6d.

Tourret, R. **"Performance of Metal-cutting Tools."** *London, Butterworths Scientific Publications,* 1958. 184 *pages. Diagrams.* 50s.

"In this book, an attempt has been made to gather together published information concerning the mechanical and physical performance of metal-cutting tools, and to show how that information may be correlated. The aim has been to co-ordinate this information as a physical phenomenon with the main considerations being the forces involved, the tool wear and life, and the surface finish obtained on the work material. Contents:

Introduction
Types of cutting operations — Tool nomenclature — Types of chip formation.

Theory of Continuous Chip Formation
Cutting speed — Feed — Tool shape — Tool material — Job material — Drills — Taps — Slab Mills — Lubricant.

Tool Life
Cutting speed — Tool temperature — Feed — Tool shape — Tool material — Job material — Vibration — Drills — Lubricant.

Surface Finish
Cutting speed — Feed — Depth of cut — Tool shape — Method of tool preparation — Tool wear — Vibration — Lubricant.

Williams, G. A. **"Heating in Industry."** *Richmond, Surrey, Association of Engineering and Shipbuilding Draughtsmen, Session* 1954 - 1955. 100 *pages. Diagrams. Tables.* 3s.

Contents: The transfer of heat — Heat and the human body — The thermal environment — The assessment of the heat losses from a building — Gravity flow hot water systems — Forced circulation hot water systems — Hot water systems generally — Steam heating systems — High pressure hot water — Heating apparatus — Measurements and thermostatic controls — Heating by gas and electricity — Comparison of heating systems, choice of plant, practice — Radiant heating — Tables. There are worked examples throughout the book and reference is made to British Standards.

Williams, G. A. **"Ventilating in Industry."** *Richmond, Surrey, Association of Engineering and Shipbuilding Draughtsmen, Session* 1954 - 1955. 36 *pages. Diagrams.* 3s.

Contents: Ventilation — The design of duct systems — Air filters — The measurement of air flow — Standards of ventilation, air movement, air distribution, humidity control, air conditioning.

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1958/1959

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Vice-President
T. H. Hunter

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J. Renwick A. C. Wotherspoon

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T. F. B. de Villiers F. Westall

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Eastern	A. B. Brook	**Scotland**	J. Nicolson Low
Midlands	A. C. Turner	**South Eastern**	J. Aikman
North Midlands	C. N. T. Manfull	**Southern**	J. W. Taylor
Northern	A. Smith	**South Western**	A. Eustace
North Western	J. P. Speakman	**Wales**	C. Ll. Griffiths

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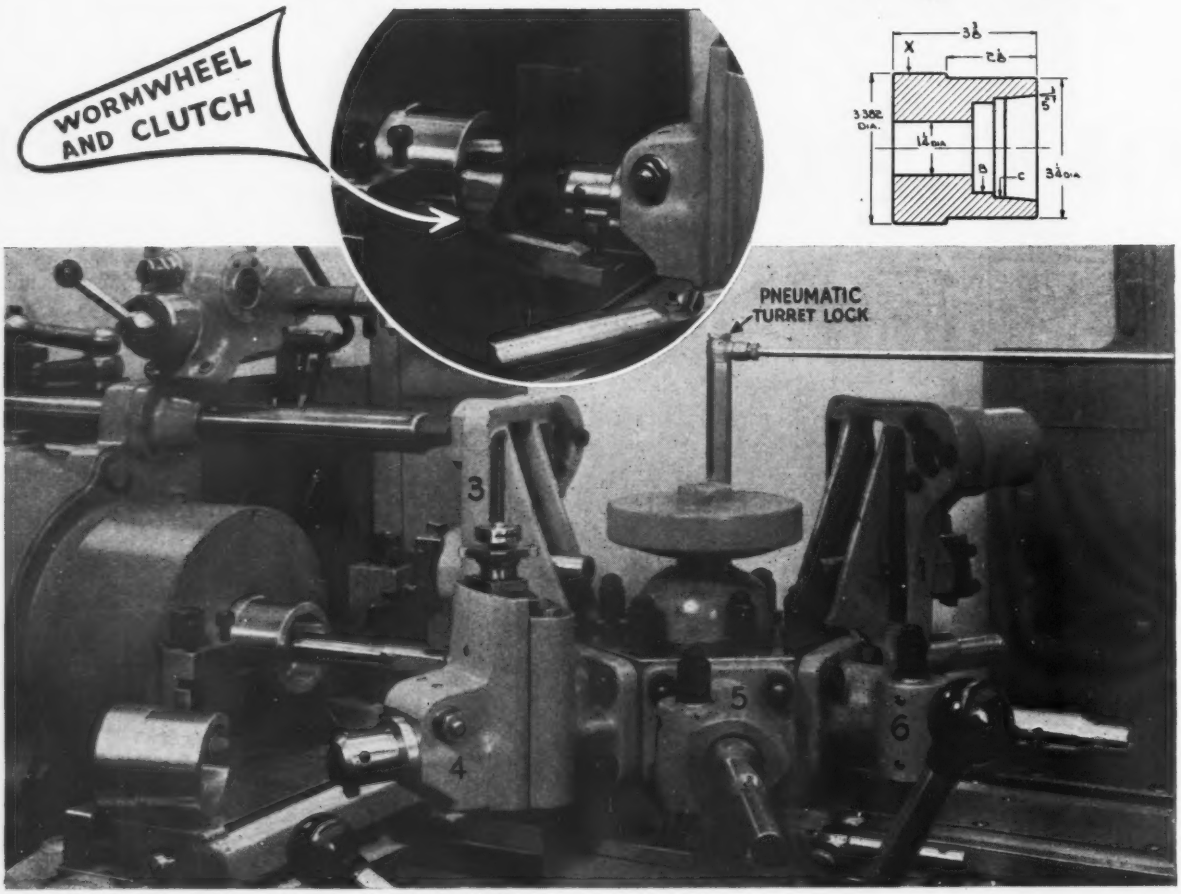

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	Hex. Turret	Cross-slide			
1. Chuck on X	—	—	—	—	—
2. Rough Face End	—	Rear	540	480	Hand
3. Rough Bore 1¼" and Knee Turn 3¼"	1	—	540	480	125
4. Finish Bore B and C	2	—	955	624	125
5. 2nd Bore 1¼" dia. Finish Knee Turn 3¼"	3	—	955	812	125
6. Face End and Radius	—	Front	1650	1404	Hand
7. Taper Bore (2 Cuts)	4	—	1650	1080	234
8. Microbore 1¼" dia.	5	—	1650	540	234
9. Chamfer Corners	6	—	1650	1080	Hand
10. Remove	—	—			

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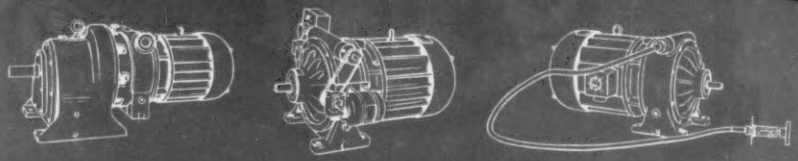

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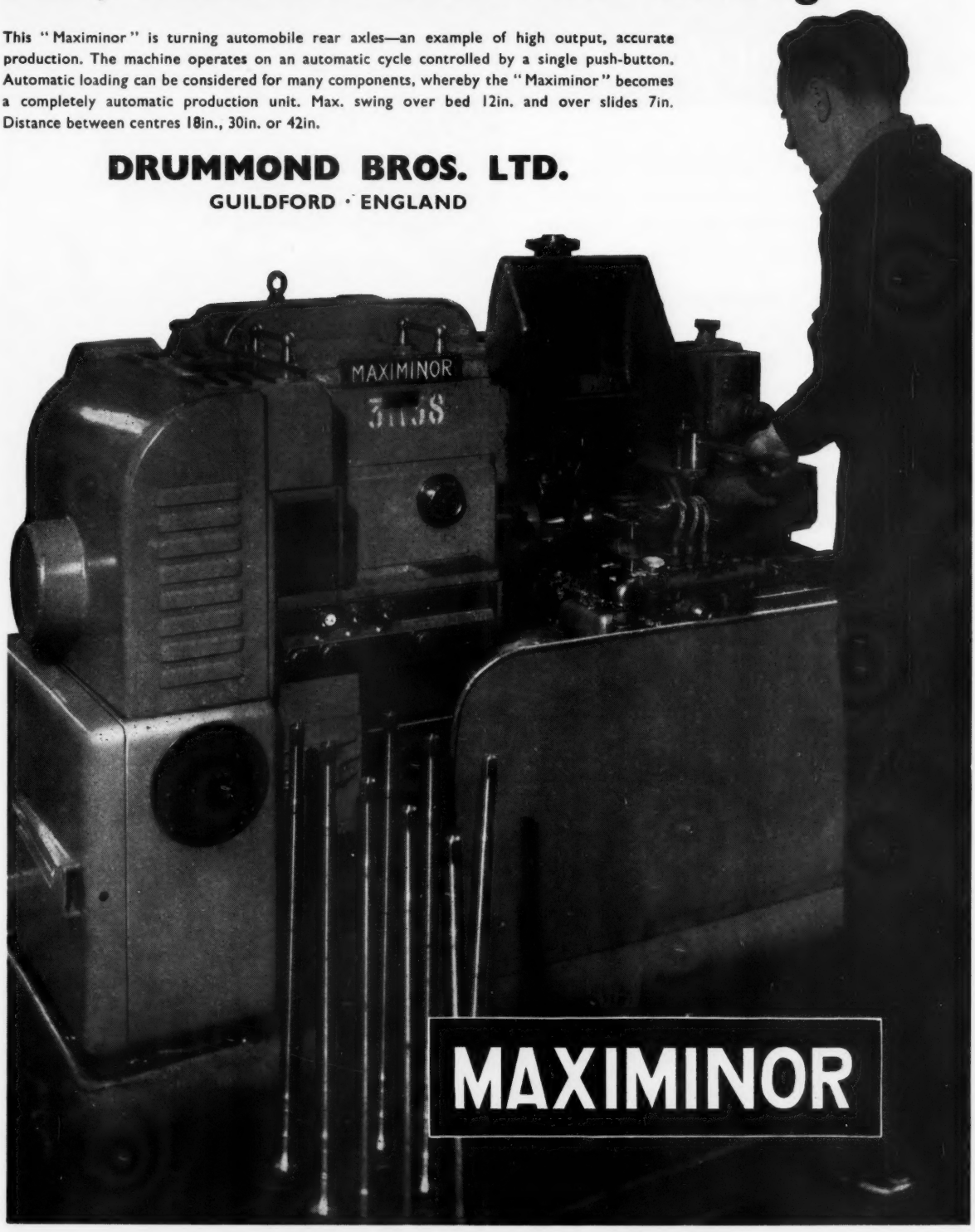

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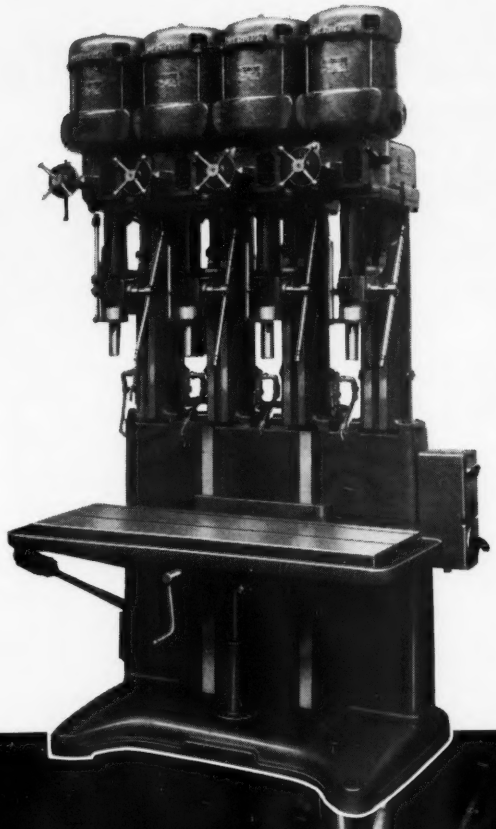

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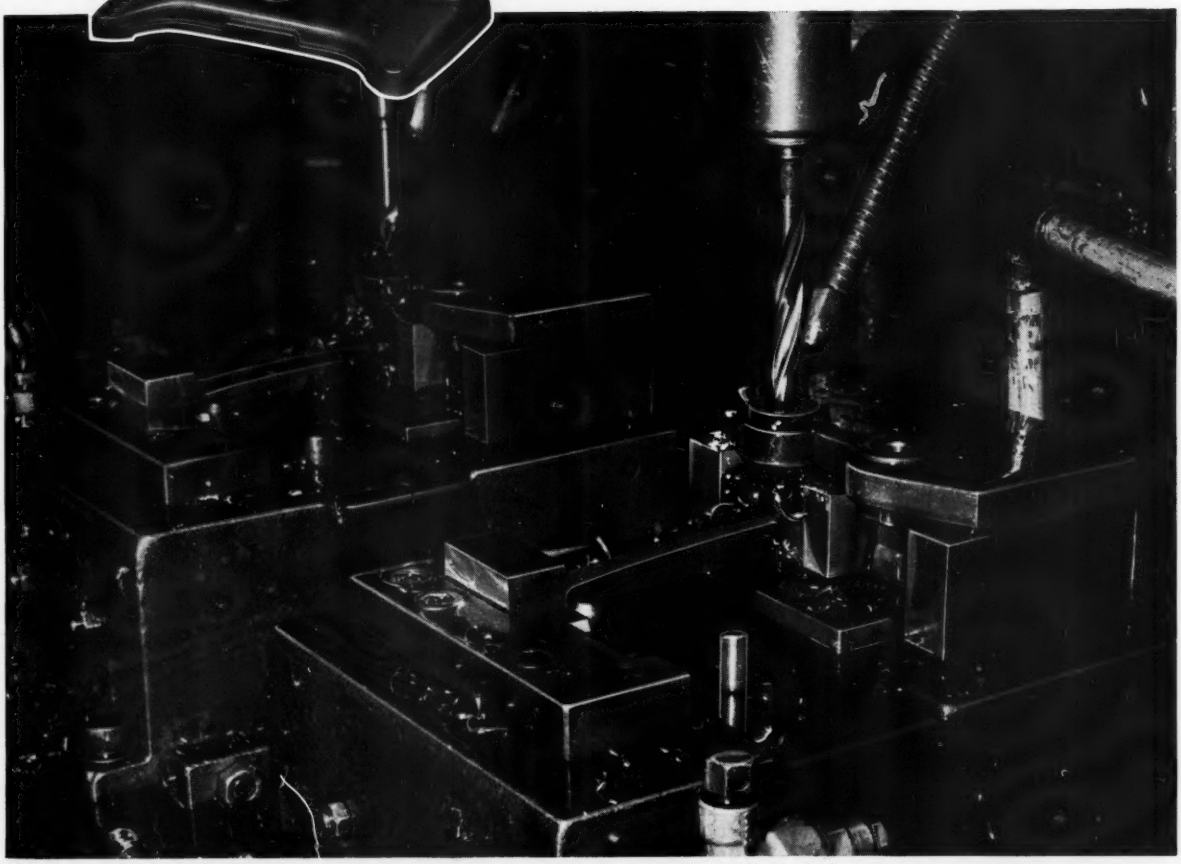

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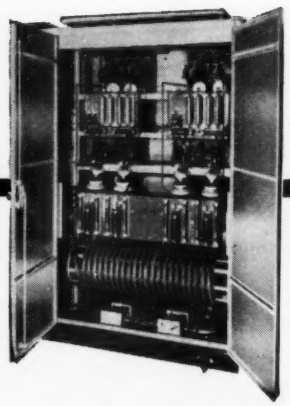
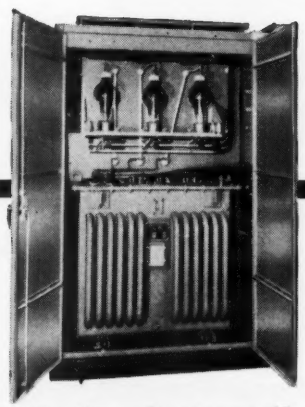


Oscillator valve section.



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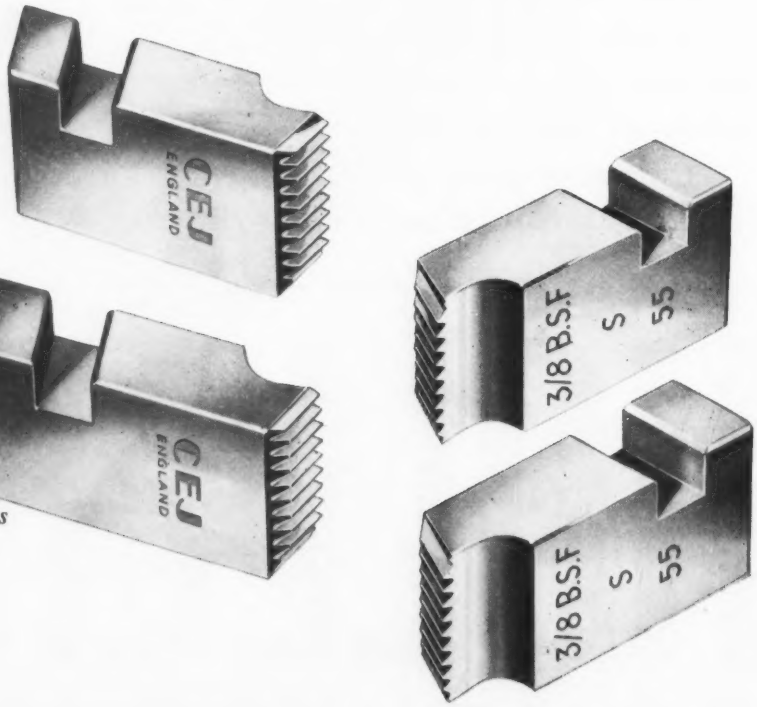

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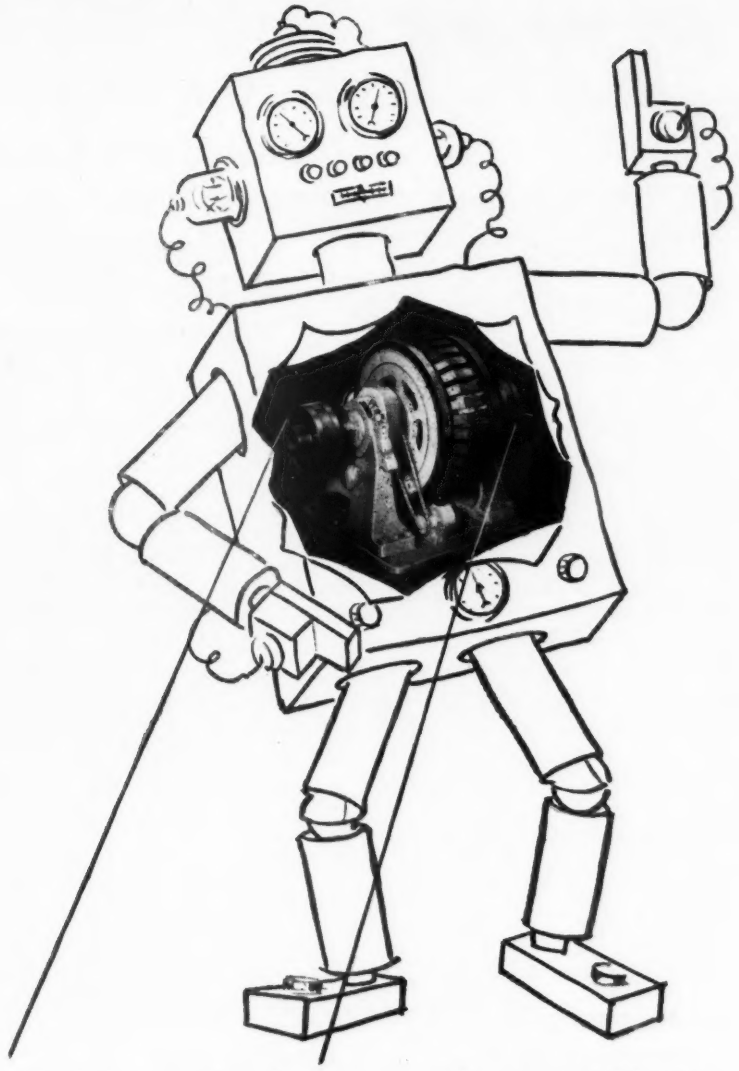

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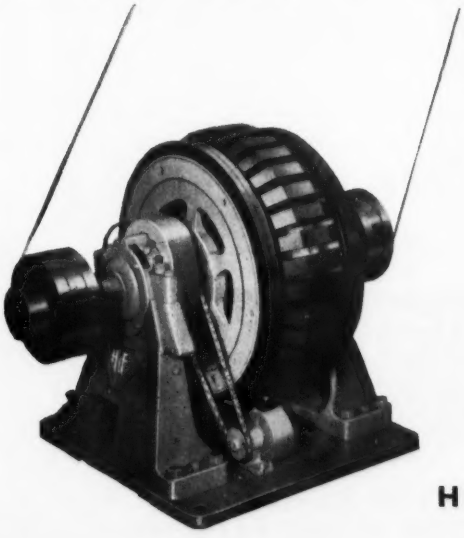

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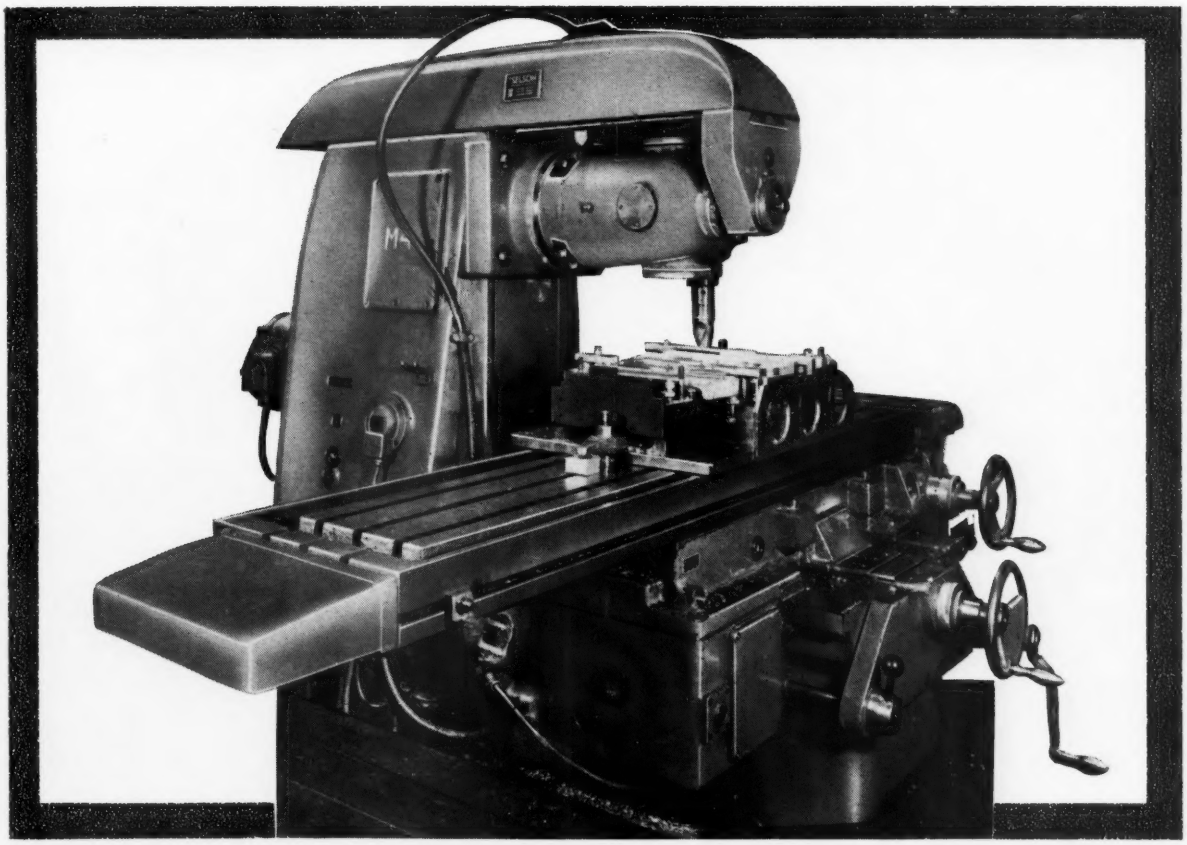

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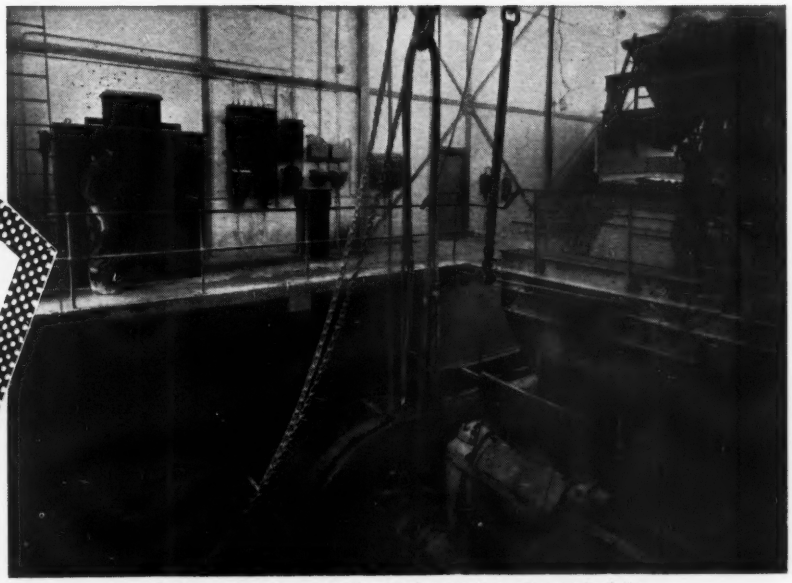
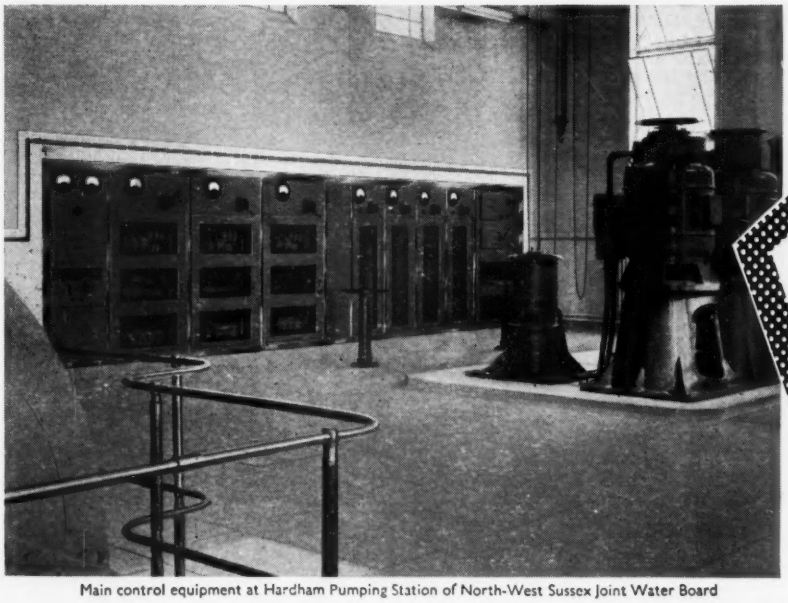


Contactor equipment providing hand-operated speed control of the Primary Crusher of Cornelly Quarry of The Steel Company of Wales Ltd



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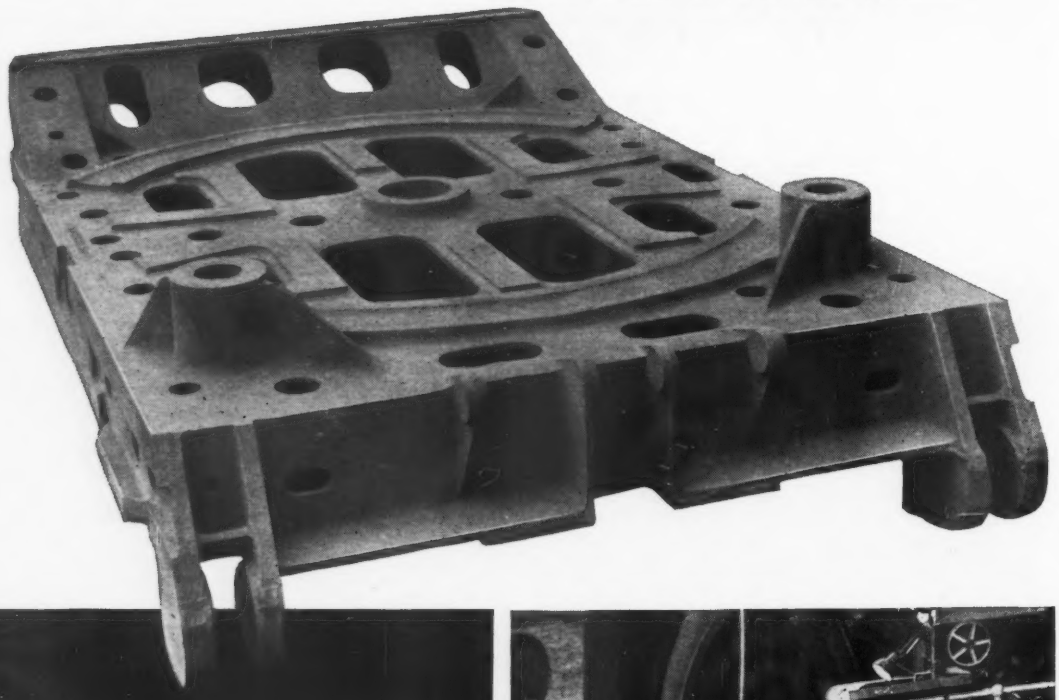

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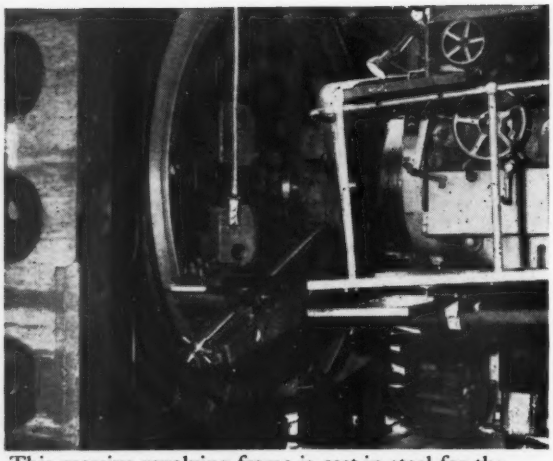

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This carbon control unit is of major importance in that it results in a tremendous increase in the versatility of our world renowned Homocarb electric gas carburising furnace. In addition to its original function of case carburising it can now be used for carbon restoration and homogeneous carburising with great advantage. In carburising, for instance, excess carbides can be prevented; networks and retained austenite can be eliminated, this reducing rejects and lengthening the life of the product. Carbon restoration and homogeneous carburising, previously difficult or impossible to control on production work, are now thoroughly practicable.

Consideration of the above facts will suggest to you that its vastly increased versatility makes the Homocarb furnace an almost indispensable item of Heat Treatment equipment.

The illustration pictures an installation working at Jaguar Cars Ltd.

The attractive Microcarb control booklet will be sent to you with pleasure on request and a Technical Representative will wait on you if you so desire.

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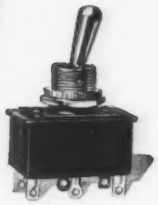
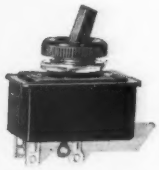
Switches

For Instrument and Electronic Applications



* Cat. No. 81058-BT. Double Pole Double Throw. 2 Position Lever Type. Back Connecting Lugs.

Cat. No. 81046. Single Pole Single Throw. 2 Position Lever Type. Back Connecting Lugs.



Cat No. 81055-B-BP. Double Pole Single Throw. 2 Position Insulated Lever Type. Back Connecting Lugs.

The exacting conditions of service demanded by modern techniques in electronic equipment and instrument development are fully matched by this new range of ARROW bakelite enclosed switches.

Their main characteristic is the maintenance of low contact resistance after considerable life.

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* BIASED ACTION SUPPLIED FOR ALL CIRCUITS

Maximum rating 3 amps at 250V AC/DC

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Developed for quicker and more efficient cutting-off of all types of material, steel, iron, brass, bronze, light alloys, etc. Capacity of 16" x 6" for rectangular sections or 10" for round bars, fitted with hydraulic down feed enabling thin parallel cuts to be made in any material, leaving a smooth even face.

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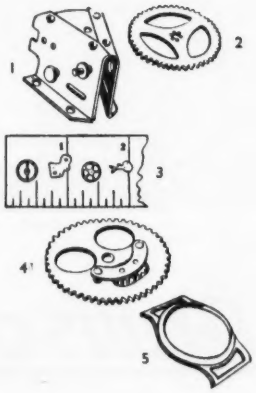

1. Three hollow rivets and single ball end rivet fastened. Single Operation.

2. Wheel stabbed to form keys. Single Operation.

3. Crop form after Auto turning. Pierce holes and form Location Studs. Pierce centre hole. Pierce two smaller holes and crop form at small end.

4. Hollow rivets on saddle fastened. Single Operation.

5. Forming on Strap-holders.

	H.3	H.5
Capacity	1 ton	2 ton
Throat to centre of Ram	$2\frac{1}{2}$"	$3\frac{1}{2}$"
Maximum daylight	$3\frac{1}{4}$"	$5\frac{3}{8}$"
Stroke	$1\frac{13}{16}$"	$2\frac{5}{16}$"

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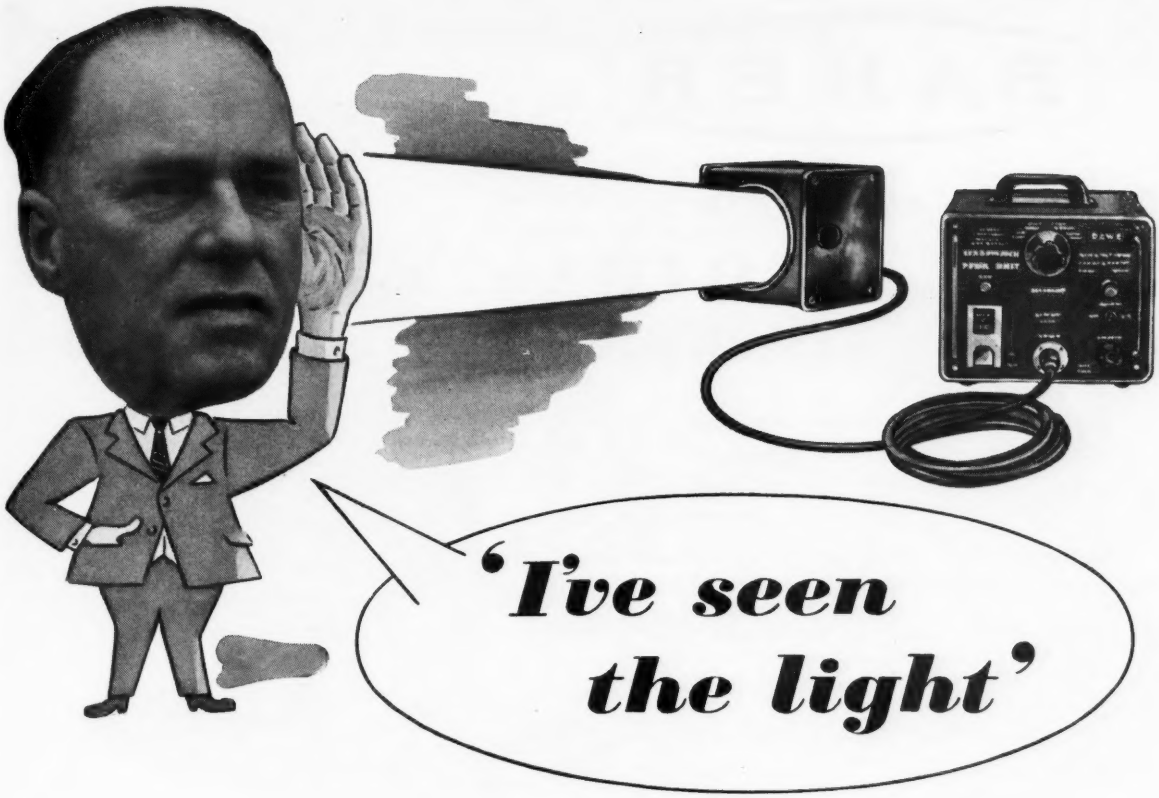

SAID Mr. DAWE WITH A GRIN

'Sir?' we said.

'Just a little joke about stroboscopes', said Mr. Dawe.

'Oh' we said.

'But seriously' continued Mr. Dawe briskly, 'since we **are** *the biggest manufacturers of stroboscopes in Europe, why don't we make a little modest capital out of the fact?'.*

'Why not?' we said.

'And, at the same time, we ought to shout about the **scope** *of our stroboscopes, if you follow me'.*

'We don't' we said.

'Well' replied Mr. Dawe wih justifiable pride. 'Our equipment can measure rotational speeds as low as 120 *r.p.m. and as high as* 600,000 *r.p.m. Why not write something pungent, witty and unforgettable about that?'.*

'We will' we said.

'But don't let the fact that stroboscopes have a strong connection with seeing things in slow motion affect you personally' said Mr. Dawe meaningly.

DAWE INSTRUMENTS LTD.

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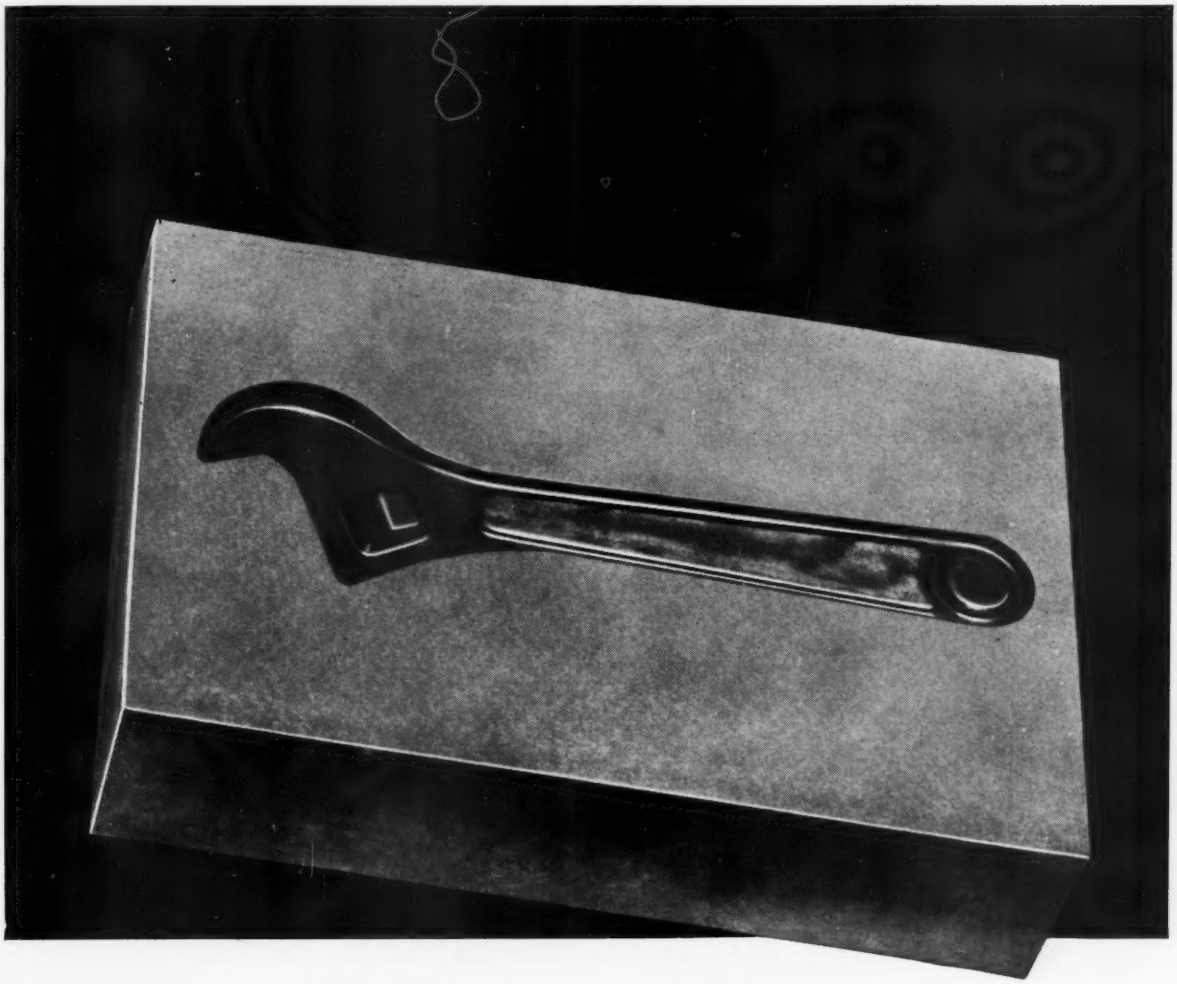


How long by your methods?

This six inch long spanner body die was formed in six hours using a GKN Spark Machine. The die required no further finishing before use.

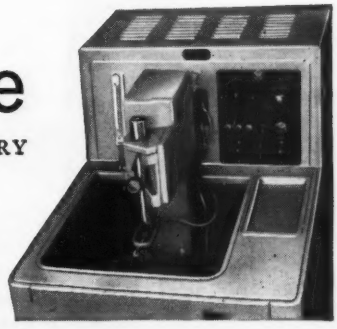
GKN Electro Erosion simplifies intricate shaping :— makes easy the working of hardened steels and tungsten carbide.

A GKN Spark Machine gives a high cutting rate with low electrode loss and a good surface finish for dies, moulds, press tools, and form tools of a difficult and intricate nature. Its operation is safe, simple, speedy, and accurate.

Further details of the GKN Spark Machine and its many advantages can be obtained without obligation from Welsh Metal Industries, or Sales Agents.

GKN spark machine

DESIGNED BY THE GKN RESEARCH LABORATORY



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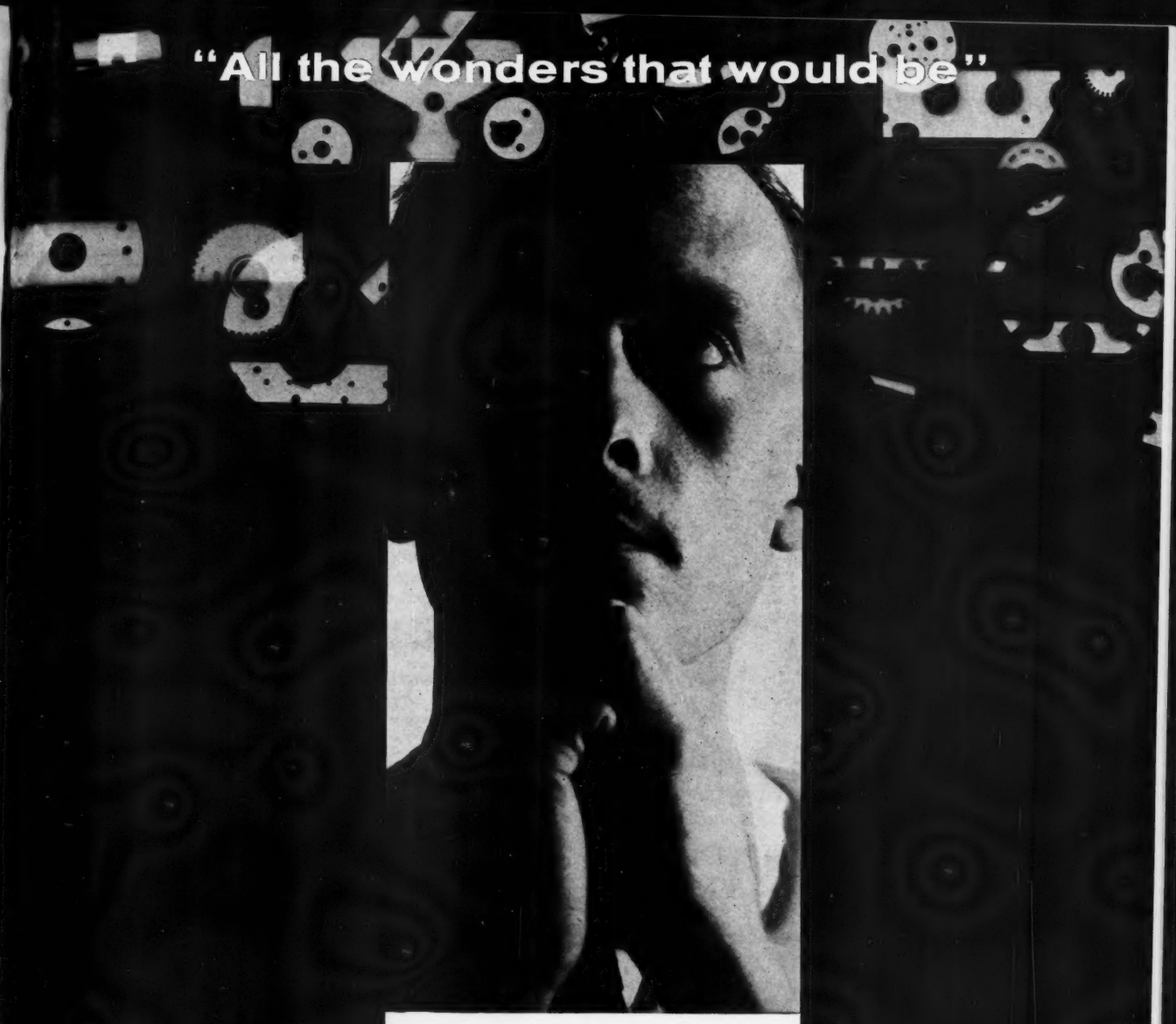

Insulator Division

Electro-ceramic insulators, mass-produced to close dimensional tolerances, for radio, telecommunication and electronic apparatus, cooking, heating and pyrometric equipment.

Electric Heating Division

'Chromalox' ceramic-embedded strip, ring, pad and cartridge electric heating elements and 'Tubalox' sheathed wire elements for domestic and industrial purposes. Also complete appliances including air and immersion heaters.

Gas Burner Division

Non-corrosive ceramic tipped gas jets and gas burners for domestic and industrial heating and lighting together with a comprehensive range of spray jets for chemicals, oils and other fluids.

In the forward march of industry, progress starts with visionaries' dreams... with dreams awaiting translation into practical possibilities. And that's where Geo. Bray have a part to play. In close on a century, the Company has made many dreams come true, turning the ideas of others and of themselves —for Geo. Bray engineers are visionaries too—into solid realities.

For lighting and heating, for electrical insulation, for precision engineering, there is hardly an industry that does not rely on the products of this 95-year-old Company. Today, forward-looking people are constantly coming to the Insulator, Electric Heating and Gas Burner Divisions of Geo. Bray for advice on the development of new ideas in these all-embracing fields.

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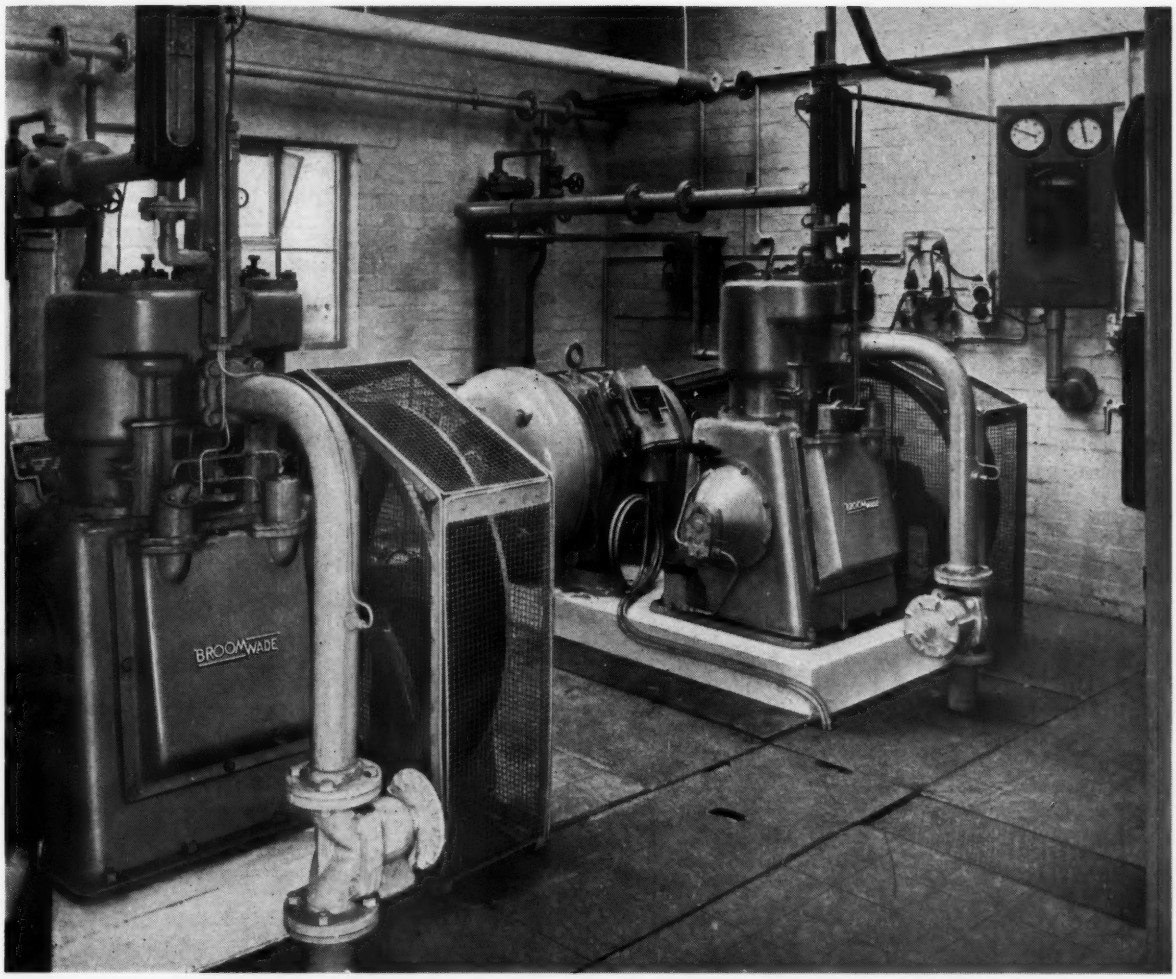

"BROOMWADE" aids I.C.I. Paint Production

" BROOMWADE " pneumatic equipment is widely used at the I.C.I. Works in Slough, where the famous " Dulux " brand paints are made.

The illustration shows two D.23 compressors used for inert gas, a mixture of nitrogen and carbon dioxide used in the manufacture of paints, varnishes and synthetic resins. Each compressor discharges 220 cu. ft. of "free" inert gas at pressures up to 100 p.s.i.g.

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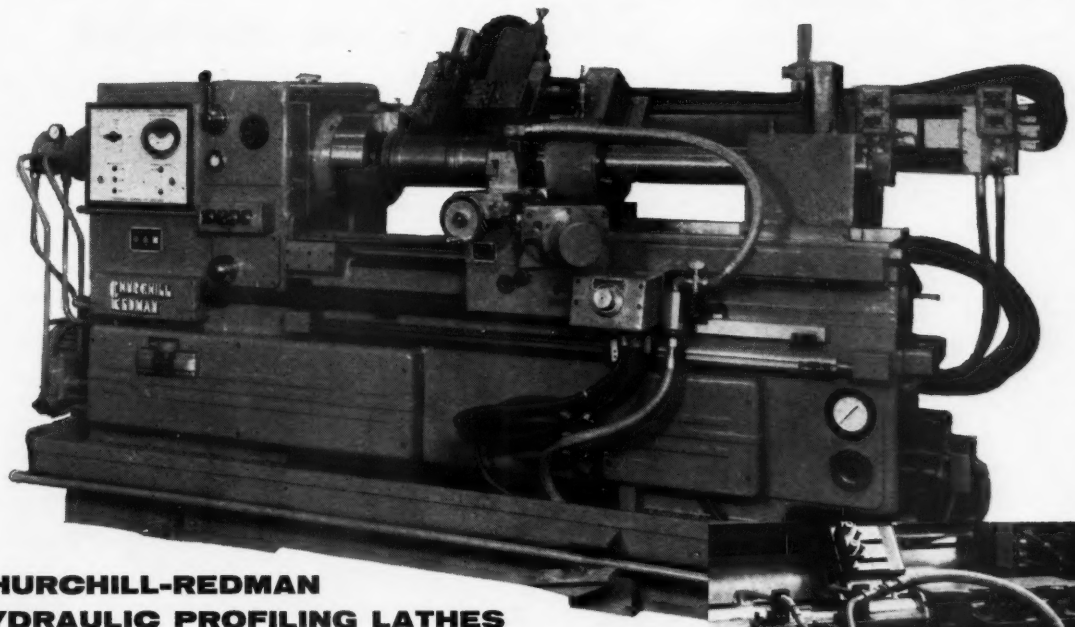
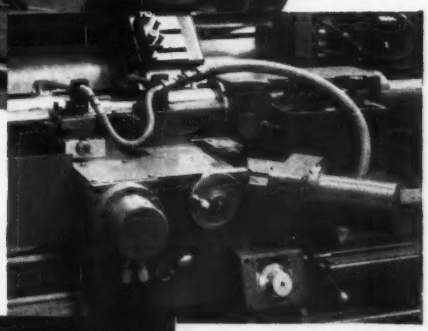




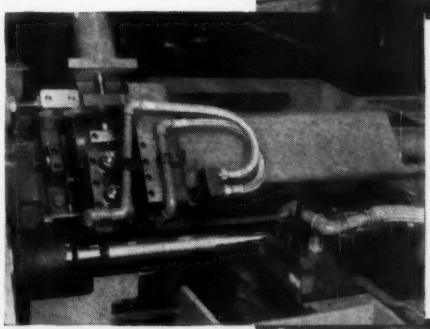
CHURCHILL-REDMAN HYDRAULIC PROFILING LATHES

BORING AND TURNING CYLINDER LINERS

14″ x 40″ Model Profiling Lathe with automatic push button control and tooled to parallel bore, profile turn and part off C.I. Cylinder Liners.
10 Minutes Floor to Floor Time — 14″ long x 6″ o.d. Liner.

TURNING TRUCK AXLE TUBES

12″ x 40″ Model Profiling Lathe turning axle tubes complete. Special carriage with parallel and profile turning tools.
4½ Minutes Floor to Floor Time — 33″ long x 4½″ o.d.



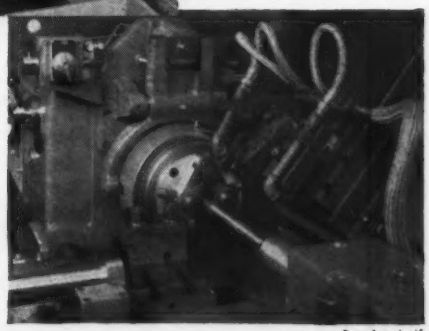
MACHINING TWIST DRILLS

12″ x 40″ Model Profiling Lathe turning Twist Drills complete. Rear slide parallel turns H.S.S. body. Carriage profile turns shank.
2¼ Minutes Floor to Floor Time — 2″ dia. Twist Drill.

CHURCHILL-REDMAN
HL Series
Model 12″ x 20″
Model 12″ x 40″
Model 14″ x 20″
Model 14″ x 40″
Model 14″ x 60″

TURNING AND KNURLING BOLTS

12″ x 20″ Model Profiling Lathe profile turning outside diameter complete. Special hydraulically operated knurling attachment knurls head of bolt.
1½ Minutes Floor to Floor Time — 1″ dia. 10½″ long bolt.



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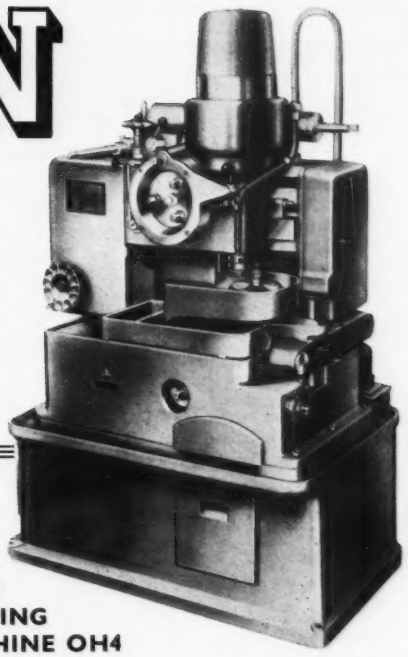
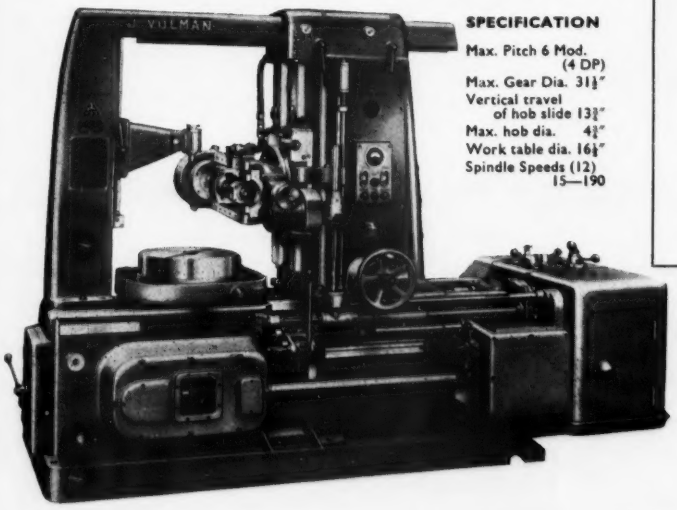
VOLMAN

GEAR SHAPING
GEAR HOBBING
GEAR MILLING
MACHINES



GEAR HOBBING MACHINE FO6

The heavy duty Volman Gear Hobbers are unexcelled for high rate production of precision spur, helical and worm gears. Tangential head available for cutting worm wheels.



SPECIFICATION

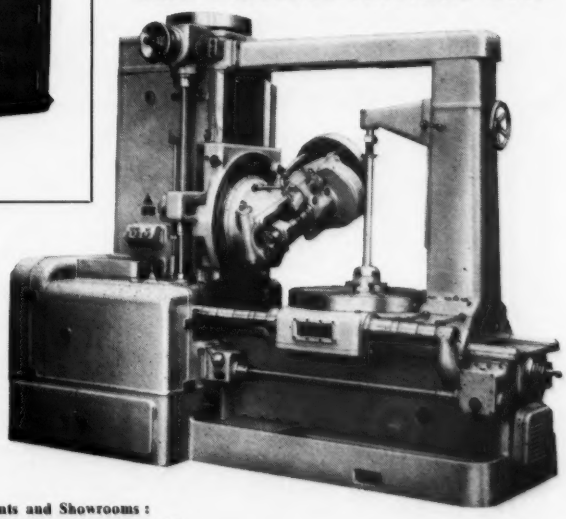
Max. Pitch 6 Mod. (4 DP)
Max. Gear Dia. 31½"
Vertical travel of hob slide 13¾"
Max. hob dia. 4¾"
Work table dia. 16½"
Spindle Speeds (12) 15—190

GEAR SHAPING MACHINE OH4

For rapid production of internal and external spur, single and double helical gears, segment gears, ratchets, cams.

SPECIFICATION	*External*	*Internal*
Max. dia. of spur gears	7½"	6½"
Max. dia. of helical gears	7½"	6½"
Min. gear diameter	⅜"	1½"
Max. gear width	1½"	1⅜"
Max. Pitch 4 Mod. (6 DP)		

GEAR HOBBING MACHINE OFI0



SPECIFICATION

Max. gear dia. 49"
Max. dia. with support 29½"
Max. pitch 10 module
Work table dia. 33½"
Spindle Speeds (10) 20-125 r.p.m.

OH4, OH6, FO6, OFI0

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for Higher National Diploma in Production Engineering

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In the final year all subjects are assessed. Full exemption from the Associate Membership examination of The Institution of Production Engineers is given to graduates of the course under the present regulations.

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W. N. HOWARD,
Director of Education.

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C. E. GURR, M.Sc., Ph.D.,
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Full details of the Courses may be obtained from the Principal.

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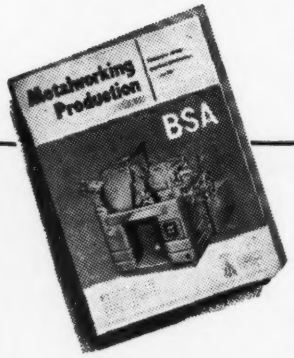

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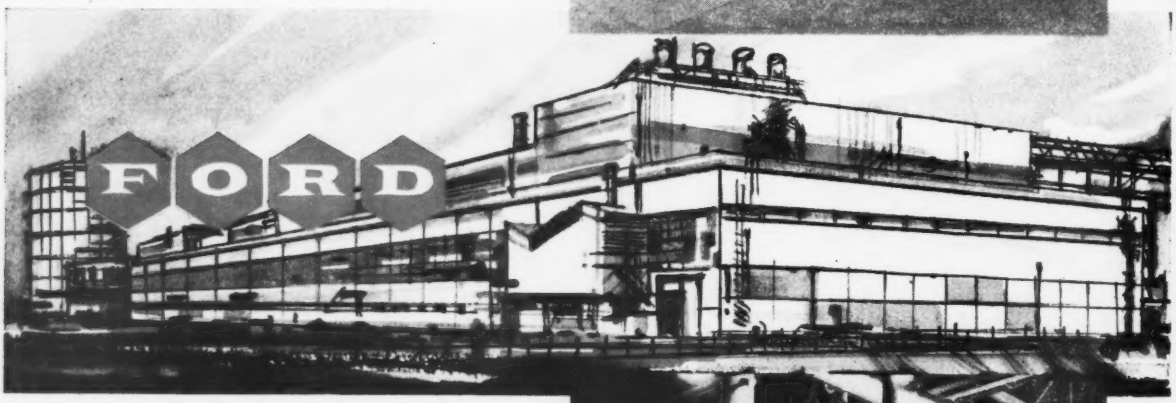

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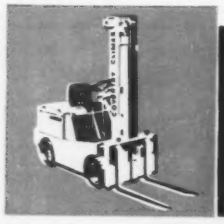

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